Chapter Forty-nine

3R GUIDELINES FOR RURAL AND URBAN HIGHWAYS (Non-Freeways)

BUREAU OF DESIGN AND ENVIRONMENT MANUAL

Chapter Forty-nine
3R GUIDELINES FOR RURAL AND URBAN HIGHWAYS
(Non-Freeways)

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Chapter Forty-nine

3R GUIDELINES FOR RURAL AND URBAN HIGHWAYS (Non-Freeways)

49-1 INTRODUCTION

Section 31-6 identifies four project scopes of work:

- new construction;
- reconstruction;
- 3R (resurfacing, restoration, rehabilitation) (non-freeways); and
- 3R (resurfacing, restoration, rehabilitation) (freeways).

The applicable chapters in Parts IV and V present the Department's design criteria that apply to new construction and reconstruction projects. For these projects, the designer often has the liberty of designing the highway to meet the most desirable and stringent criteria possible. Therefore, exceptions to these criteria should be relatively rare.

Highways constructed to meet nationally recognized design criteria provide measurable advantages for the motoring public. The safety, comfort, and convenience of modern highways present strong incentives for funding programs based on ideal design considerations. However, available finances do not always permit the reconstruction of existing highways to an ideal level. A comparison of Statewide needs demonstrates that, with available revenues, the problem must be addressed not only at a project level but on a system-wide basis.

Therefore, the design of projects on existing highways must be viewed from a different perspective. These projects are often initiated for reasons other than geometric design deficiencies (e.g., pavement deterioration), and they often must be designed within restrictive right-of-way, financial limitations, and environmental constraints. As a result, the design criteria for new construction and reconstruction are often not attainable without major and, frequently, unacceptable adverse impacts. At the same time, however, the Department must exercise the opportunity to make cost-effective, practical improvements to the geometric design of existing highways and streets.

For these reasons, the Department has adopted revised limits for geometric design values for projects on existing highways that are, in many cases, lower than the values for new construction/reconstruction. These criteria are based on a sound, engineering assessment of the underlying principles behind geometric design and on how the criteria for new construction/reconstruction can be legitimately modified to apply to existing highways without sacrificing highway safety.

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Chapter 49 presents the Department's criteria for 3R projects on rural and urban highways (non-freeways), and Chapter 50 presents the criteria for 3R freeway projects. These criteria are intended to find the balance among many competing and conflicting objectives. These include the objective of improving Illinois' existing highways; the objective of minimizing the adverse impacts of highway construction on existing highways; and the objective of improving the greatest number of miles (kilometers) within the available funds.

As a summary, Chapter 49 presents 3R criteria for:

- two-lane rural arterial highways (other than freeways) (Section 49-3);
- urban arterial highways and streets (other than freeways) (Section 49-4);
- high-speed, multilane highways (other than freeways) (Section 49-5); and
- rural unmarked collector or local routes on the State highway system (Section 49-6).

This chapter is not applicable to projects that are generally considered to be resurfacing-only type projects (e.g., maintenance overlays,) or fall under the Pavement Preservation Policy (3P).

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49-2 GENERAL

49-2.01 Background

49-2.01(a) Federal 3R Regulations

The *Federal-aid Highway Act* of 1976 amended the term "construction" to permit Federal-aid funding of resurfacing and widening and resurfacing of existing rural and urban pavements with or without revision to the horizontal or vertical alignment or other geometric features. The 1982 *Surface Transportation Assistance Act* stipulated that resurfacing, rehabilitation, and restoration (3R) projects be constructed to standards to preserve and extend the service life of highways and enhance safety.

On June 10, 1982, the FHWA issued its Final Rule entitled *Design Standards for Highways; Resurfacing, Restoration and Rehabilitation of Streets and Highways Other Than Freeways,* which adopted a flexible approach to the geometric design of 3R projects. In the Final Rule, FHWA determined that it was not practical to adopt 3R design criteria for nationwide application. Instead, each State can develop its own criteria and/or procedures for the design of 3R projects, subject to FHWA approval, to tailor its design criteria according to the conditions that prevail within that State. This approach is in contrast to the application of geometric design criteria for new construction and reconstruction, for which the AASHTO *A Policy on Geometric Design of Highways and Streets* provides nationwide criteria for application.

49-2.01(b) Special Report 214

In 1987, the Transportation Research Board published Special Report 214 *Designing Safer Roads; Practices for Resurfacing, Restoration and Rehabilitation*. The *Surface Transportation Assistance Act* of 1982 mandated this study. The objective of the TRB study was to examine the safety cost-effectiveness of highway geometric design criteria and to recommend minimum design criteria for 3R projects on non-freeways. The final TRB report (SR 214) presented specific numerical criteria for the geometric design of 3R projects for the following elements:

- lane and shoulder widths,
- horizontal curvature and superelevation,
- crest vertical curvature,
- bridge width,
- side slopes, and
- pavement cross slopes.

The SR 214 information has been considered, where appropriate, for the Department's criteria and procedures for 3R projects.

49-2.01(c) FHWA Technical Advisory T5040.28

Pursuant to its adoption of SR 214, FHWA issued on October 17, 1988, Technical Advisory T5040.28 "Developing Geometric Design Criteria and Processes for Non-Freeway RRR Projects." The purpose of the Advisory is to provide guidance on developing or modifying

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criteria for the design of Federal-aid, non-freeway 3R projects. The information from the Technical Advisory has been considered, where appropriate, for the Department's criteria and procedures for 3R projects.

49-2.02 <u>Objectives</u>

From an overall perspective, the 3R program is intended to improve the greatest number of highway miles (kilometers) within the available funds for highway projects. Improve is meant to apply to all aspects that determine a facility's serviceability, including:

- the structural integrity of the pavement, bridges, and culverts;
- the drainage design of the facility to, among other objectives, minimize ponding on the highway, to protect the pavement structure from failure, and to prevent roadway flooding during the design-year storm;
- from a highway capacity perspective, the level of service provided for the traffic flow;
- the adequacy of access to abutting properties;
- the geometric design of the highway to safely accommodate expected vehicular speeds and traffic volumes;
- the roadside safety design to reduce, within some reasonable boundary, the adverse impacts of run-off-the-road vehicles; and
- the traffic control devices to provide the driver with critical information and to meet driver expectancies.

These objectives are competing for the limited funds available for 3R projects on existing highways. The Department's goal is to realize the greatest overall benefit from the available funds. Therefore, on individual projects, some compromises may be necessary to achieve the goals of the overall highway program. Specifically for geometric design and roadside safety, the balance is between what is desirable (new construction/reconstruction) and what is practical for the specific conditions of each highway project.

Therefore, based on these objectives, the Department has adopted and FHWA has approved its policy for the geometric design of 3R projects. These objectives are summarized as follows:

1. 3R projects are intended to extend the service life of the existing facility and to return its features to a condition of structural or functional adequacy. This includes providing smoother riding surfaces and structurally improving bridges.
2. 3R projects are intended to enhance highway safety. Safety improvements should be selected to support the State's Strategic Highway Safety Plan (SHSP) and "Zero Fatalities" goal. To accomplish this, identified "Five Percent" locations, and other locations and conditions that present cost-effective opportunities to reduce fatal and

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severe injury crashes must be identified and examined in order to apply 3R funds effectively. 3R projects are intended to incorporate cost-effective, practical improvements to the geometric design of the existing facility. This includes increasing roadway and bridge widths.

49-2.03 Application

The design policies and criteria in Chapter 49 apply to 3R projects on existing facilities within the general constraints of the existing alignment and right-of-way. If the purpose and scope of the project is intended to replace or expand the facility, then Chapter 49 is not appropriate, and reconstruction policies will apply. For definitions and application to new construction and reconstruction projects, see Section 31-6.

49-2.04 3R Project Evaluation

Sections 49-3 through 49-6 present the specific geometric design and roadside safety criteria that will be used to define the scope of 3R projects. In addition, the designer should consider several other factors and conduct applicable technical evaluations using appropriate Department units as may be necessary. The potential evaluations are discussed below:

1. Conduct Field Review. The district will normally conduct a thorough field review of the proposed 3R project to ascertain the appropriateness of 3R criteria and on-site conditions and their effects on project development decisions. Other personnel should accompany the designer as appropriate, including district scoping, safety, environmental, Operations, Project Implementation, Bureau of Safety Programs and Engineering, Bureau of Design and Environment, and FHWA (on applicable Interstate projects or project included in a FHWA specific project PoDI plan (see Section 4-2), etc. Objectives of the field review should be to collect relevant field data, to identify potential safety problems, and to determine the need for safety improvements to the facility.

2. Document Existing Geometrics. The designer will normally review the most recent as-built highway plans and combine this with the field review to determine the existing geometrics within the project limits. The review includes lane and shoulder widths, horizontal and vertical alignment, intersection geometrics, and the roadside safety design. A field survey may also be needed to verify certain geometric features.

3. Safety Analysis. Conduct a project safety analysis as described in Chapter 11-2.02(f) for each 3R project.

4. Crash Data. Crash data and analysis of the data are critical to the identification of problem areas. The Phase I engineering report shall include the identified Five Percent Report (FPR) Location evaluations and schematic collision diagrams.

   The designer shall evaluate the last three years of crash data available, identify over-represented crash trends, and propose appropriate countermeasures. The Phase I

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engineering report shall include schematic collision diagrams and recommendations based on an analysis for all crash patterns throughout a proposed project. The diagrams should show the location and type of crashes for the previous three years.

5. Early Coordination for Right-of-Way (ROW) Acquisition. ROW acquisitions are sometimes required for 3R projects. Therefore, determine the improvements that will be incorporated into the project design as early as feasible and initiate the ROW process.

6. Pavement Condition. 3R projects are often programmed because of a significant deterioration of the pavement structure. The extent of deterioration will influence the decision on whether a project can be designed using the 3R design criteria or whether it should be designed using new construction/reconstruction criteria. In addition, all 3R projects shall include a pavement surface that meets the Department's skid resistance criteria. See Chapter 53 for the Department's policies, procedures, and criteria for the rehabilitation of existing pavements.

   Whenever the proposed pavement improvement is major, it may be practical to include significant geometric improvements (e.g., lane and shoulder widening) in the project design. However, the proper level of geometric improvement is often determined by many additional factors other than the extent of pavement improvement. These include available right-of-way, environmental studies, traffic volumes, crash experience, and available funds for the project. Therefore, it may be appropriate for the 3R project to include, for example, full-depth pavement reconstruction and minimal geometric improvement, if supported by safety studies and the operational objectives of the 3R program.

7. Geometric Design of Adjacent Highway Sections. The designer should examine the geometric features and operating speeds of highway sections adjacent to the 3R project. This will include investigating whether or not any highway improvements are in the planning stages. The 3R project should provide design continuity with the adjacent sections. This involves a consideration of factors such as driver expectancy, geometric design consistency, and proper transitions between sections of different geometric designs.

8. Continuity of Design. Consistency is an important factor to be considered in the development of 3R projects. 3R projects are based on current traffic; however, consider the probable future traffic to ensure the appropriate use of 3R policies. Avoid the use of design changes that violate driver expectancy regarding width, curvature, or other roadway features, as practical. Continuity of design may justify constructing certain highway elements to higher or lower design criteria than normally prescribed.

9. Physical Constraints. The physical constraints within the limits of the 3R project may determine what geometric improvements are practical and cost-effective. These include topography, adjacent development, right-of-way, utilities, and environmental constraints. Identified safety countermeasures relative to impacts and costs should be considered and an appropriate balance achieved.

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10. Traffic Control Devices. All signing and pavement markings on 3R projects shall meet the criteria of the *Illinois Manual on Uniform Traffic Control Devices*. The Bureau of Operations is responsible for selecting and locating the traffic control devices on the project. The designer should work with the Bureau to identify possible geometric and safety deficiencies that will remain in place (i.e., no improvement will be made).

11. Bridges Within Project Limits. One or more bridges may be within the limits of a 3R project. If bridge improvement is needed, it may be performed prior to, simultaneous with, or deferred from highway projects in accordance with the priorities established in the applicable sections of Chapter 49 (e.g., Section 49-3.09 for rural arterials).

    Highway bridge improvement includes all work necessary for the improvement of existing rural or urban bridges to be consistent with 3R objectives for increased safety, improved operating conditions, and structural adequacy. Bridge improvement could include complete replacement of a bridge when no other cost-effective means of meeting these criteria are feasible. For definition and clarification, a bridge constructed at a different location or an existing bridge requiring replacement of all elements as a part of a 3R project is designated as a replacement rather than a new bridge. New bridge designations are reserved for new construction/reconstruction projects because they generally are subject to different width requirements than replacement bridges.

12. Design Exceptions. The use of lower design criteria than described in Chapter 49 will require approval from BDE and, where applicable, FHWA. Where exceptions to these criteria are necessary, they should be processed according to the procedures described in Section 31-8.

13. Spot Improvements. Recently completed spot improvements (e.g., safety or bridge projects) may be considered for omission from 3R projects. The proposed limits of an omission should be identified, and all applicable features within the limits of the spot improvement should be discussed at district coordination meetings and included in the Phase I engineering report. These reports should also discuss the omissions to ensure that they are treated in accordance with 3R policies. Any exceptions to the 3R criteria within omissions shall be identified and addressed in accordance with the 3R procedures.

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49-3 TWO-LANE RURAL ARTERIAL HIGHWAYS

49-3.01 Application

Section 49-3 is applicable to resurfacing, rehabilitation, and restoration (3R) projects on the State highway system that are:

- marked two-lane rural arterials,
- marked two-lane rural highways functionally classified as collectors,
- unmarked two-lane rural arterials, or
- expressways (project-by-project basis).

49-3.02 Design Speed

The typical design speed for rural arterial 3R projects is 55 mph (90 km/h), or the regulatory speed, whichever is less.

49-3.03 Roadway Cross Section Elements

Figure 49-3.A presents design criteria for roadway cross section elements for 3R projects on rural two-lane arterial highways. The proposed improvements are primarily related to existing roadway widths and traffic volumes.

49-3.04 Horizontal Alignment

49-3.04(a) General

Engineering judgment and/or a cost-effectiveness evaluation will reveal the need for improvements to the horizontal alignment within a 3R project. In general, improvements to existing horizontal alignment and/or superelevation should be considered if a specific problem is identified. Examples include:

- a disproportionate number of run-off-the-road crashes,
- a disproportionate number of multi-vehicle crashes at curve sites, and/or
- the presence of a major intersection within a horizontal curve.

The evaluation of potential improvements will include the consideration of existing curvature, speed, traffic volumes, truck volumes, right-of-way and utility impacts, environmental impacts, driver expectancy, construction costs, etc.

Current ADT	EXISTING Traveled Way WIDTHS		
	18 ft – 20 ft (5.48 m - 6.10 m)	22 ft (6.71 m)	24 ft (7.32 m)
	PROPOSED IMPROVEMENT WIDTHS		
3000 or more [1]	Traveled Way • WRS to 24 ft (7.2 m) • Stripe for 24 ft (7.2 m)	Traveled Way • RS • Stripe for 22 ft (6.6 m)	Traveled Way • RS • Stripe for 24 ft (7.2 m)
	Width of Shoulder Construction • Construct 3 ft (900 mm) paved + 3 ft (900 mm) aggregate wedge[2]	Width of Shoulder Construction • Construct 3 ft (900 mm) paved + 4 ft (1.2 m) aggregate wedge [2]	Width of Shoulder Construction • Construct 3 ft (900 mm) paved + 3 ft (900 mm) aggregate wedge [2]
2999 to 1000	Traveled Way • WRS to 26 ft (7.8 m) • Stripe for 24 ft (7.2 m)	Traveled Way • RS • Stripe for 22 ft (6.6 m)	Traveled Way • RS • Stripe for 24 ft (7.2 m)
	Width of Shoulder Construction • Construct 1 ft (300 mm) paved [4] + 3 ft (900 mm) aggregate wedge	Width of Shoulder Construction • Construct 1 ft (300 mm) paved[3][6] + 4 ft (1.2 m) aggregate wedge	Width of Shoulder Construction • Construct 1 ft (300 mm) paved[6] + 3 ft (900 mm) aggregate wedge
Less than 1000	Traveled Way • WRS 18 ft – 24 ft (5.48 m to 7.2 m) and stripe for 22 ft (6.6 m) • RS 20 ft (6.10 m) and stripe for 20 ft (6.0 m)	Traveled Way • RS • Stripe for 20 ft (6.0 m)	Traveled Way • RS • Stripe for 22 ft (6.6 m)
	Width of Shoulder Construction • Construct 1 ft (300 mm) paved[4] + 3 ft (900 mm) aggregate wedge • Construct 1 ft (300 mm) paved[5][6] + 3 ft (900 mm) aggregate wedge	Width of Shoulder Construction • Construct 1 ft (300 mm) paved[5] + 3 ft (900 mm) aggregate wedge	Width of Shoulder Construction • Use 1 ft (300 mm) paved + 3 ft (900 mm) aggregate wedge

WRS = Widening and Resurfacing
RS = Resurfacing Only

Note: See next page for footnotes.

ROADWAY CROSS SECTION ELEMENTS
(3R Projects — Two-Lane Rural Arterials)

Figure 49-3.A

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Notes to Figure 49-3.A.

(1) *Roadway widths less than 34 ft (10.3 m) generally will be widened to meet one of the following widths depending on the width of the existing traveled way:*

Existing Traveled Way Width	*Pavement/Striped Width*	*Proposed Shoulder Width*	*Total Roadway Width After Construction*
22 ft (6.71 m)	*22 ft (6.7 m/6.6 m)*	*8 ft (2.4 m)*	*38 ft (11.5 m)*
18 ft – 20 ft (5.48 m - 6.10 m)	*24 ft (7.2 m/7.2 m)*	*8 ft (2.4 m)*	*40 ft (12.0 m)*
24 ft (7.32 m)	*24 ft (7.3 m/7.2 m)*	*8 ft (2.4 m)*	*40 ft (12.0 m)*

The paved shoulder will be 3 ft (900 mm) wide, and the remainder will be an aggregate wedge as noted in Figure 49-3.A except as modified by Note (2).

In some cases, widening an existing roadway to only 34 ft or 36 ft (10.3 m or 10.9 m) may be permitted, depending on the existing traveled way width and right-of-way conditions. Where the existing traveled way is 22 ft or 24 ft (6.7 m or 7.3 m) wide, the construction of 6 ft (1.8 m) shoulders may be considered if such a proposed roadway width can reasonably be accommodated within the existing right-of-way, and a 38 ft to 40 ft (11.5 m to 12.1 m) roadway will require additional right-of-way.

(2) *Use an aggregate wedge for part of the shoulder on roadways with a current ADT up to 5000. For roadways where the current ADT is more than 5000, the aggregate wedge will be replaced by a minimum aggregate thickness of 6 in. (150 mm) (minimum design considered as stabilized aggregate). Where the stabilized width of shoulder construction from Figure 49-3A is less than the proposed shoulder width in Footnote (1), the proposed width of the aggregate wedge or stabilization should be increased to include the remaining shoulder width. See the Highway Standards for details.*

(3) *Where resurfacing is proposed on a Class II Designated Truck Route or where the ADT of multiple-unit trucks exceeds 250, the paved shoulder should be increased to 2 ft (600 mm) wide, and the width of aggregate wedge should be decreased by 1 ft (300 mm).*

(4) *The 1 ft (300 mm) paved shoulder width is constructed as an integral part of the pavement widening. See the* Highway Standards *for details.*

(5) *Where an unusually high number of multiple-unit trucks are present or anticipated (e.g., coal hauling routes) on a highway, the designer may consider providing 11 ft (3.3 m) travel lanes with resurfacing or 11 ft (3.3 m) travel lanes with widening and resurfacing and striping for 1 ft (300 mm) paved shoulders in both cases. For an existing 20 ft (6.1 m) traveled way, the designer may consider the option of only resurfacing the traveled way and constructing 2 ft (600-mm) paved shoulders.*

(6) *All 1 ft (300 mm) wide paved shoulders under "Proposed Improvement Widths" which are not an integral part of the widening should be 6 in. (150 mm) thick. See the Highway Standards for details.*

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49-3.04(b) Radius of Curvature/Superelevation

It is often impractical and unnecessary to correct horizontal curves on 3R projects to meet new construction/reconstruction criteria for the minimum radius of curvature. Consequently, existing horizontal curves should be evaluated to determine if an existing horizontal curve should remain in place; if there is a need for providing more superelevation on a curve; or if the curve must be reconstructed. Reconstruction should be considered only if at least one of the following conditions is met:

1. Safety analysis indicates a problem at the curve site.

2. The comfortable operating speed of an existing horizontal curve is more than 15 mph (25 km/h) below the 3R design speed (or posted or regulatory speed if less than 55 mph (90 km/h)). This assumes an increased superelevation rate cannot reduce this difference. Figure 49-3.B should be used to determine the comfortable operating speed of an existing curve. This figure is based on AASHTO's Method 2 for the distribution of superelevation and side friction.

   Comfortable operating speed is defined as the speed at which a motorist can drive an existing horizontal curve and still feel comfortable traversing the curve. In all cases, maximum comfortable side friction (f) is assumed. See Section 32-2.

If it is determined to reconstruct a curve to meet the minimum radius criteria, the curve typically should be reconstructed to meet all horizontal alignment details for new construction/reconstruction (e.g., superelevation rate, superelevation transition lengths, distribution of superelevation runoff between tangent and curve) as discussed in Chapter 32.

If it is determined to retain an existing curve based on the above criteria, the designer still may be able to cost effectively improve other details of the horizontal curve. The following are potential improvements:

1. Improve the frictional characteristics of the roadway with a new pavement surface.

2. Increase the superelevation rate by specifying a tapered overlay.

3. Improve the superelevation transition length.

4. Specify wider lanes throughout the curve and use paved shoulders. Also, add reflectorized pavement markers to the centerline.

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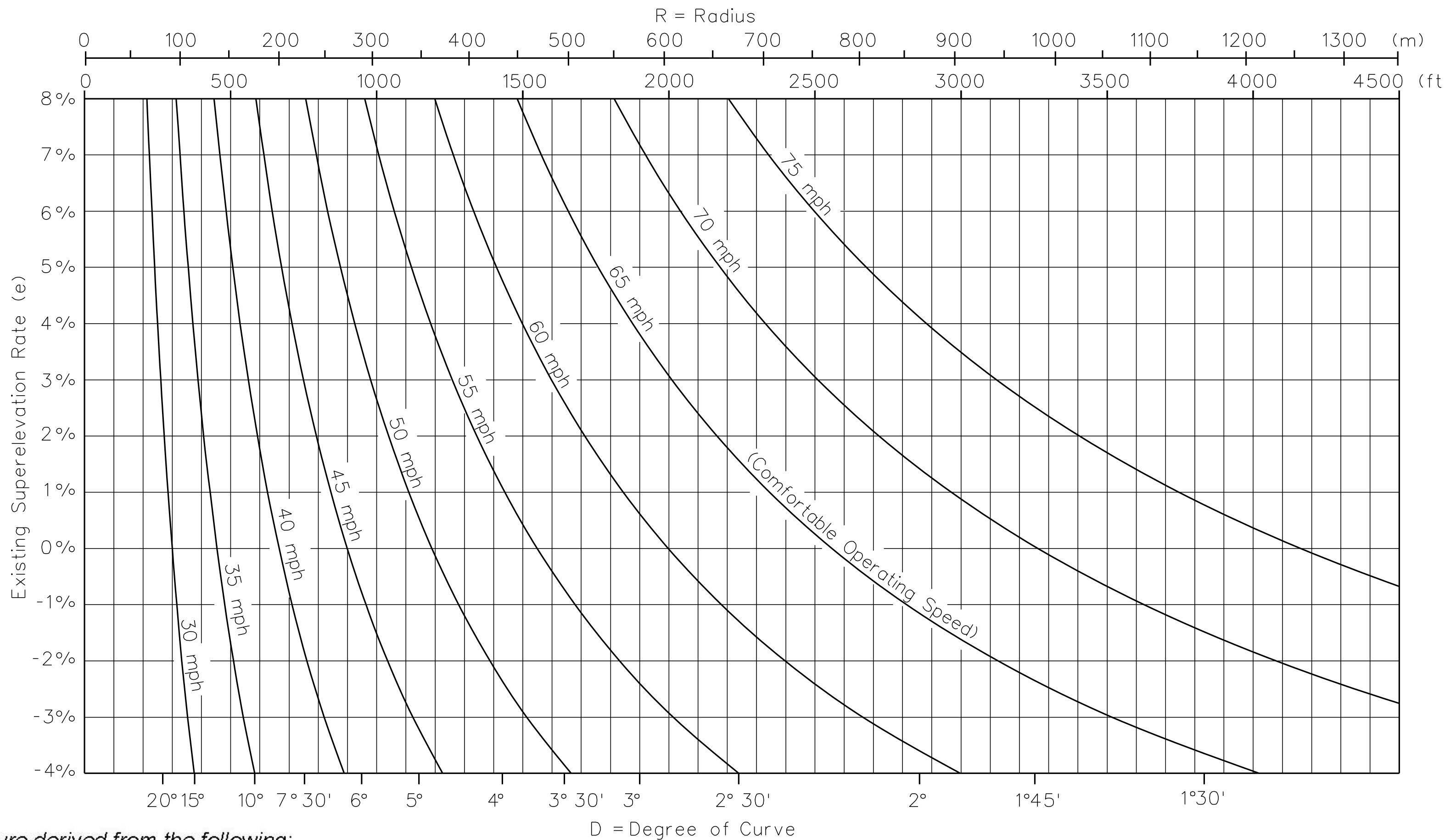

Figure derived from the following:

1. *Use AASHTO Method 2 for the distribution of superelevation and side friction.*
2. *Assume design speed and use f_{max} for selected design speed in all cases.*
3. *Assume different values of "e" and calculate values for "R" on graph for each speed.*

$$R=\frac{V^2}{15\,(e+f_{max})}$$ *, where V = mph and R = ft. (US Customary)*

$$R=\frac{V^2}{127\,(e+f_{max})}$$ *, where V = km/h and R = m. (Metric)*

HORIZONTAL CURVATURE ALLOWED TO REMAIN IN PLACE FOR 3R NON-FREEWAY PROJECTS

Figure 49-3.B

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Notes on How To Use Figure 49-3.B

1. *Figure 49-3.B. applies to all rural highways (open-roadway conditions) and to all urban highways and streets.*

2. *Obtain existing curve radius and the surveyed superelevation rate. Plot point on graph and determine comfortable operating speed for existing conditions. TRB Special Report 214 and FHWA Technical Advisory T5040.28 (October 17, 1988) both are used as references for 3R work. They may be referenced for further information.*

3. *If existing conditions do not provide a sufficiently high speed, then increase the superelevation rate up to a maximum of 8% to increase the comfortable operating speed on the curve.*

4. *If increasing the superelevation rate up to 8% does not provide a sufficiently high comfortable operating speed to allow a curve to remain in place, then the designer shall consider realigning the curve. The following applies:*

    a. *The preferred alternative is to upgrade the curve (using new construction criteria) to the appropriate design speed for the given functional classification. This is accomplished by using AASHTO Method 5 for superelevation rates and for the calculation of curve radii. See Section 32-2.*

    b. *In certain cases, a second alternative for reconstruction may be considered for curve realignment. This might occur where environmental issues become critical, where right-of-way is determined to be highly restricted, or where a major at-grade intersection falls within the limits of the curve and the curve radius cannot be increased due to alignment restrictions. The maximum superelevation rate typically used on curves at a major crossroad intersection is 4%. In this case, the designer may determine the appropriate radius by using AASHTO Method 2 for superelevation and side-friction distribution. Figure 49-3.B values would apply.*

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49-3.04(c) Treatment of Existing Horizontal curves

The basic objectives for improving operating speeds on horizontal alignment of rural type highways with ADTs of 1000 or more are:

- to determine if a horizontal curve can remain in place by increasing superelevation up to a maximum of 8% which, in turn, will provide a comfortable operating speed of 40 mph (65 km/h) or greater;
- to retain existing horizontal curves adequate for comfortable operating speeds of 40 mph – 50 mph (65 km/h – 80 km/h) by increasing the superelevation rate;
- to determine appropriate superelevation rates on horizontal curves adequate for speeds greater than 50 mph (80 km/h); and
- to realign horizontal curves not adequate for a 40 mph (65 km/h) comfortable operating speed when the design speed is 55 mph (90 km/h).

Regulatory Speed on Adjacent Tangents is 50 mph (80 km/h) or Greater and Current ADT >1000

1. Radius Less Than 460 ft (140 m). The following applies:

   a. Realign horizontal curve according to functional classification of highway and use appropriate design speed criteria (see applicable chapter in Part V) or, in some cases, use Figure 49-3.B to determine curvature. See the footnotes for Figure 49-3.B for determination of cases.

   b. If the proposed realignment lies along a highway with a lower current traffic volume, a 60 mph (100 km/h) design speed may be considered for the realignment if this is compatible with the remainder of the route.

   c. The following design features will apply to any realignments:

      - The traveled way should be 24 ft (7.2 m) wide, and the lanes should be striped 12 ft (3.6 m) wide through the curve.
      - The shoulders should be 8 ft (2.4 m) wide. The minimum paved shoulder will be 1 ft (300 mm) wide, and an aggregate wedge will be provided adjacent to the paved shoulder. Stabilization could be wider to be compatible with the remainder of the project.
      - Front slopes generally should be 1V:4H, but they may vary in relationship to prevailing slopes throughout the project and/or adjacent roadway sections. Back slopes generally should not be steeper than 1V:3H.

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2. Radius 460 ft to 750 ft (140 m to 230 m). The following applies:

   a. Retain existing horizontal curvature and use an 8% superelevation rate.

   b. Find comfortable operating speed from Figure 49-3.B and post with an advisory speed as follows:

      - For 40-42 mph (64–68 km/h) operating speeds, post curve at 40 mph.
      - For 43-47 mph (69–76 km/h) operating speeds, post curve at 45 mph.
      - For 48-50 mph (77–80 km/h) operating speeds, post curve at 50 mph.
      - For operating speeds greater than 50 mph (80 km/h), no posting is required.

   c. The following design features will apply to horizontal curves in this category:

      - Lanes should be a minimum of 12 ft (3.6 m) wide through the curve.
      - The minimum paved shoulder widths are 1 ft (300 mm) on the outside and 3 ft (900 mm) on the inside of the curve. Stabilization could be wider to be compatible with the remainder of the project.
      - A minimum stopping sight distance for 50 mph (80 km/h) should be considered across the inside of the curve. See Section 32-4.
      - Where the district determines that the truck volumes are high, consider using 13 ft (4.0 m) lanes through the curve. Curve widening on the inside generally is preferable.
      - Reflectorized pavement markers should be placed along the centerline of the curve.

3. Radius Greater than 750 ft (230 m). The following applies:

   a. Superelevate curve in accordance with Figure 49-3.B to accommodate the tangent regulatory speed.

   b. The following design features will apply to horizontal curves in this category:

      - Use a minimum of 12 ft (3.6 m) lanes.
      - The minimum paved shoulder widths are 1 ft (300 mm) on the outside and 3 ft (900 mm) on the inside of the curve. Stabilization could be wider to be compatible with the remainder of the project.
      - A minimum stopping sight distance for 55 mph (90 km/h) should be considered across the inside of the curve. See Section 32-4.
      - Reflectorized pavement markers should be placed along the centerline of the curve.

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Regulatory Speed on Adjacent Tangents is 45 mph (75 km/h) or Less in Rural Areas or Where Rural Cross Sections Exist

1. If the comfortable operating speed using an 8% superelevation rate equals at least 30 mph (50 km/h) (R = 250 ft (75 m)), then the horizontal curve may be retained. Appropriate advisory speeds shall be posted.

2. For curves with radii of 250 ft to 600 ft (75 m to 180 m), use an 8% superelevation rate to accommodate the tangent regulatory speed. Refer to Figure 49-3.B and post the appropriate advisory speed.

3. For curves with radii greater than 600 ft (180 m), superelevate the curve to accommodate the tangent regulatory speed by using an e_{max} up to 6%. Refer to Figure 49-3.B.

Regulatory Speed on Adjacent Tangents is 50 mph (80 km/h) or Greater and Current ADT < 1000

1. If the comfortable operating speed using an 8% superelevation rate equals at least 35 mph (60 km/h) (R = 350 ft (106 m)), then the horizontal curve may be retained. Appropriate advisory speeds shall be posted.

2. For curves with radii of 350 ft to 750 ft (106 m to 230 m), use an 8% superelevation rate to accommodate the tangent regulatory speed. Refer to Figure 49-3.B and post the appropriate advisory speed.

3. For curves with radii greater than 750 ft (230 m), superelevate the curve by using Figure 49-3.B to accommodate the tangent regulatory speed.

49-3.04(d) Superelevation Transition Lengths

The length of superelevation transition consists of two parts — the length of superelevation runoff and the length of tangent runout. For a discussion of superelevation development, see Section 32-3.

When the regulatory speed on an adjacent tangent is 50 mph (80 km/h) or greater and the radius of the curve is greater than 750 ft (230 m), a desirable superelevation transition length of 230 ft (70 m) should be used. The minimum superelevation transition length should be approximately 200 ft (60 m).

For all other speed and curve combinations in a rural area, a desirable superelevation transition length of approximately 200 ft (60 m) should be used. The minimum superelevation transition length should be approximately 150 ft (45 m).

For new construction and reconstruction projects, the Department’s practice is to provide 67% of the superelevation runoff on tangent and 33% on curve. However, due to the nature of 3R projects, the location of superelevation runoff lengths with respect to the PC and PT may vary,

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and strict compliance with this runoff ratio is not mandatory. Where reverse curves may restrict the distribution of the runoff, a ratio of 50% on tangent and 50% on curve may be used for the superelevation runoff.

49-3.04(e) Traveled Way/Shoulder “Rollover”

Through horizontal curves where the proposed or remaining shoulder width is 6 ft (1.8 m) or wider, the maximum rollover (algebraic difference between slopes) at the intersection of the traveled way and shoulder should not be greater than 10%. Where the shoulder width is 4 ft (1.2 m) or less, the maximum rollover may be 12%. Where 1 ft (300 mm) wide paved shoulder strips are used, the rollover should occur at the edge of the paved shoulder rather than at the traveled way edge for ease of construction.

49-3.04(f) Summary

Figure 49-3.C summarizes the horizontal curve criteria for 3R projects on rural arterial facilities.

<table>
<tr><th>Existing Comfortable Operating Speed on Curve</th><th>Posted Speed of 45 mph or Less on Adjacent Tangents</th><th colspan="2">Posted Speed of 50 mph or Higher on Adjacent Tangents</th><th>Existing Comfortable Operating Speed on Curve</th></tr>
<tr><td></td><td rowspan="2">Reconstruct</td><td><1000 ADT</td><td>>1000 ADT</td><td></td></tr>
<tr><td>< 30 mph</td><td rowspan="2">Reconstruct</td><td rowspan="3">Reconstruct</td><td>< 30 mph</td></tr>
<tr><td>30 mph</td><td rowspan="3">Improve Superelevation and Post Advisory Speed</td><td>30 mph</td></tr>
<tr><td>35 mph</td><td rowspan="4">Improve Superelevation and Post Advisory Speed</td><td>35 mph</td></tr>
<tr><td>40 mph</td><td rowspan="3">Improve Superelevation and Post Advisory Speed</td><td>40 mph</td></tr>
<tr><td>45 mph</td><td>Improve Superelevation</td><td>45 mph</td></tr>
<tr><td>50 mph</td><td rowspan="2">Not Applicable</td><td>50 mph</td></tr>
<tr><td>> 50 mph</td><td>Improve Superelevation</td><td>Improve Superelevation</td><td>> 50 mph</td></tr>
</table>

SUMMARY OF HORIZONTAL CURVE POLICY

Figure 49-3.C

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49-3.05 Vertical Alignment

49-3.05(a) Crest Vertical Curves

The following will apply:

Current ADT	Treatment
1000 or more	All existing crest curves which are not within 15 mph (25 km/h) of the posted or regulatory speed, as determined from the available stopping sight distance (SSD), will be upgraded by one of the following options: • flatten the crest curve within the existing right-of-way to satisfy 55 mph (90 km/h) (desirable) or 45 mph (70 km/h) (minimum) SSD; or • flatten the crest curve by using additional right-of-way to satisfy a 50 mph to 55 mph (80 km/h to 90 km/h) SSD; or • flatten the crest curve with sufficient additional right-of-way to satisfy the SSD design speed for reconstruction criteria. A 60 mph (100 km/h) design speed may be considered on low-volume highways. • Where a structure lies on a crest curve, flatten the approaches to a SSD design speed using reconstruction criteria. In addition through the limits of the reconstructed embankment, the improved shoulder width should be a minimum of 8 ft (2.4 m). The designer should consider sight distances, intersection influences, overall safety, the need for road closures, detours, stage construction, and especially the prevailing vertical alignment in evaluating the above alternatives. Such an analysis will allow designers to determine the most practical alternative for flattening crest vertical curves.
Less than 1000	Crest curves may be retained where the stopping sight distance on the vertical curve is no more than 20 mph (30 km/h) less than the posted or regulatory speed but not less than a 30 mph (50 km/h) available stopping sight distance.

49-3.05(b) Sag Vertical Curves

For all traffic volumes, sag vertical curves generally may be retained except for sags that include a structure requiring a complete replacement. In this case, the designer shall consider and investigate upgrading the sag vertical curve to meet a SSD design speed using reconstruction criteria versus allowing the profile to remain in place.

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49-3.05(c) Maximum Grades

Existing mainline grades are acceptable; i.e., flattening grades usually is not within the scope of a 3R project.

49-3.06 Intersections

49-3.06(a) Superelevation Rate Changes Through Intersections

Superelevation rates less than that specified for the preceding horizontal alignment may be used through certain intersections because of significant intersection conflicts and when supported in the Phase I engineering report. Refer to Figure 36-1D for guidance. Agreement should be reached with the District Operations Engineer on the appropriate advisory speed to be posted for the curve and noted in the Phase I engineering report.

49-3.06(b) Stop-Controlled Approaches on Horizontal Curves

For curved, stop-controlled approaches on State-marked routes or collector route intersections, with arterial highways, it is desirable to provide as flat an alignment as practical (with lower superelevation rates), even though traffic is operating at lower speeds than on comparable non-stop approaches. On a project-by-project basis, the benefits of higher superelevation rates for high operating speeds (during clear weather or wet pavement conditions) versus the benefits of lower superelevation for low operating speeds (during icy pavement conditions) should be carefully considered when selecting an appropriate superelevation rate. Where curve flattening is not practical, an existing curve may be retained when it will accommodate a comfortable operating speed of at least 30 mph (50 km/h) with 8% superelevation. The minimum radius in this case is 250 ft (75 m).

49-3.06(c) Sideroad Approach Grades

All connecting sideroad approaches should be examined for drainage away from the arterial route. The gradeline on the sideroad should normally drain away from the intersected arterial highway for 50 ft to 100 ft (15 m to 30 m) or, at a minimum, to the ditch line of the arterial highway. The minimum sideroad gradeline should be approximately -1.0% from the intersected State highway, and the maximum gradeline is -4.0%. Where the arterial highway is on a horizontal curve, use a maximum of -2.0% on the sideroad connection to minimize rollover at the edge of traveled way. When marked or unmarked crosswalks exist or are proposed across the intersection, roadway approach grade values more restrictive than those shown in this Section may be necessary to achieve accessibility standards. See Sections 58-1.10 and 36-1.06 for more information.

49-3.06(d) Sideroad Turning Radii

For rural arterial 3R projects, the design vehicle used for sideroad turning radii may be site specific with justification. See Section 36-1 for guidance in the selection of a design vehicle considering functional classification.

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49-3.06(e) Intersection Sight Distance (ISD)

At rural, public road intersections with a stop condition on the sideroad, provide 600 ft (180 m) of sight distance for the stopped approach in both the left and right directions along the arterial highway. Use a 12 ft (3.5 m) distance from the edge of traveled way to the driver's eye. Approval of a Level Two design exception will be required for the retention of less sight distance. In addition, the posting of a warning sign may be appropriate on the arterial highway.

49-3.07 <u>Roadside Treatment and Highway Appurtenances</u>

49-3.07(a) General

The intent of these guides is to perform cost-effective work that may reduce the number and severity of run-off-the-road crashes. Remove or shield obstacles within the clear zone, including protrusions that extend more than 4 in. (100 mm) above the ground line, where cost effective.

49-3.07(b) Earth Slopes

Other than specifically described in Section 49-3, existing parallel slopes should generally remain. Where existing right-of-way permits significant slope flattening or where grading within existing right-of-way is necessary, the designer should consider flattening earth slopes, particularly at horizontal curves.

Where considerable new right-of-way is required, front slopes should be 1V:4H or flatter and back slopes 1V:3H or flatter, but slopes may vary in relationship to prevailing conditions throughout the project and/or adjacent highway sections. Reconstructed ditch bottoms should be at least 2 ft (600 mm) wide and 3 ft (900 mm) deep.

Transverse slopes within the right-of-way shall be regraded to be not steeper than 1V:4H.

49-3.07(c) Clear Zones

For rural arterials other than at horizontal curves, clear zone widths (measured from the edge of traveled way) should be in accordance with Figure 49-3.D.

It may be warranted to expand the roadway clear zone on the outside of relatively sharp horizontal curves. This addresses the increased potential of motorists running off the roadway at curves. Figure 49-3.E presents the clear zones at horizontal curves.

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Regulatory Approach Speed and ADT	Proposed Ditch Cross Section (1)	Clear Zone
50 mph (80 km/h) or greater and ADT > 1000	Traversable	18 ft (5.5 m) or ROW line (2)
	Non-Traversable	18 ft (5.5 m) or Toe of Back Slope (2)
All Others		12 ft (3.6 m) or Non-Traversable Ditch (2)

Notes:

(1) *A traversable ditch cross section is one where the following configuration applies: 1V:4H front slopes, 2 ft (600 mm) wide ditch bottom, and 1V:3H back slopes. If any of these minimum criteria are not satisfied, the ditch cross section is considered non-traversable.*

(2) *Use whichever is less.*

CLEAR ZONES ON TANGENT SECTIONS
(3R Rural Arterial Projects)

Figure 49-3.D

Regulatory Approach Speed mph (km/h)	Comfortable Operating Speed on Curve, Range in mph (km/h)	Proposed Ditch Cross Section(1)	Clear Zone (2)
50 (80)	35-50 (55 – 80)	Traversable	25 ft (7.5 m)(3)
50 (80)	35-50 (55 – 80)	Non-traversable	25 ft (7.5 m) or Toe of Back Slope(4)
55 (90)	35-55 (55 – 90)	Traversable	25 ft (7.5 m)(3)
55 (90)	35-55 (55 – 90)	Non-traversable	25 ft (7.5 m) or Toe of Back Slope(4)

Notes:

(1) *A traversable ditch cross section is one where the following configuration applies: 1V:4H front slopes, 2 ft (600 mm) wide ditch bottom, and 1V:3H back slopes. If any of these minimum criteria are not satisfied, the ditch cross section is considered non-traversable.*

(2) *Clear zone values apply only to the outside of horizontal curves. For regulatory approach speeds less than 50 mph (80 km/h) or for comfortable operating curve speeds greater than those shown in the figure, use the roadway clear zones in Figure 49-3.D.*

(3) *Use ROW line if it is less than 25 ft (7.5 m) from edge of traveled way.*

(4) *Use whichever is less.*

CLEAR ZONES ON OUTSIDE OF HORIZONTAL CURVES
(3R Rural Arterial Projects)

Figure 49-3.E

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49-3.07(d) Guardrail

The designer should carefully analyze all existing guardrail installations to determine if the guardrail should be removed or upgraded in accordance with Section 38-6 and the following:

1. Guardrail Removal. Remove guardrail that is not warranted. An existing guardrail installation should be removed when a life-cycle benefit to cost analysis shows this is preferable to updating, and maintaining the guardrail. Benefit to cost analysis may be done using the Roadside Safety Analysis Program (RSAP), provided by AASHTO, or by using the benefit-cost tool developed to support the Highway Safety Improvement Program (HSIP) referenced in Safety Policy 1-06.

2. Guardrail Upgrading. Existing guardrail that is warranted may remain in place if it meets the all of the following:

    a. Guardrail installed using Highway Standard 630001-06 or earlier may remain in place if all of the following are met:

        - Safety analysis does not show a pattern of severe crashes related to the existing guardrail.

        - There is no loss of steel section from rusting of the steel rail, posts, or other structural components.

        - The system does not have structural damage (e.g., buckled/kinked elements, torn elements, holes). These criteria may be evaluated in light of guidelines adopted by the Department for acceptable elements.

        - Weathering steel guardrail may not remain.

        - The system must have 6 in. (150 mm) wood or approved plastic blockouts.

        - Slope from the edge of pavement to the face of rail must be 1:10 or flatter, or may be obtained by regrading if this can be done without violating any other of these requirements.

        - Height to the top of rail must be between 27 ¾ in. (705 mm) and 30 in. (760 mm) measured at the face of rail.

        - May not have any washers (e.g., “Plate Washer F” on some old Highway Standards) under bolt heads holding the rail at posts.

        - All other structural details are as shown on *Highway Standard* 630001-06. Post lengths may be confirmed from the Highway Standard in effect at the time of installation of the existing guardrail.

b. For guardrail installed under *Highway Standard* 630001-07 or later:

- There is no loss of steel section from rusting of the steel rail, posts, or other structural components.
- The system does not have structural damage (e.g., buckled/kinked elements, torn elements, holes). This criterion may be evaluated in light of guidelines adopted by the Department for acceptable elements.
- Weathering steel guardrail may not remain.
- The system must have 12 in. (300 mm) wood or approved plastic blockouts.
- Slope from the edge of pavement to the face of the rail must be 1:10 or flatter.
- Height to the top of the rail must be 28 in. (710 mm) to 32 in. (810 mm) measured at the face of the rail.
- All other functional details as shown on the current *Highway Standard* 630001 are provided. Items such as adjusting holes are not considered functional.

3. <u>End Sections</u>. Ensure all guardrail end sections for existing guardrail meets the approved lists of devices in force in December 2006, or subsequent versions appropriate for later *Highway Standards* for guardrail. Ensure all transitions from guardrail to bridge rails or to structures meet the *Highway Standards* in effect in December 2006, or subsequent versions appropriate for later *Highway Standards* for guardrail.

4. <u>Length of Need</u>. Use the length-of-need criteria in Section 38-6.01 to determine the sufficiency of the existing length of guardrail based on the posted speed. Upgrade existing guardrail that is deficient in length by more than 10 percent to provide a proper length of need. Guardrail less than 10 percent deficient may remain in place unless crash data shows that the additional length will reduce crash severity. Also, provide the proper length of need if placement of a new crashworthy terminal is required. Where practical, the designer should shorten the required length of need by tapering the barrier away from the traveled way. In addition, where an intersecting sideroad, driveway, or field entrance interferes with the placement of the length of need of continuous guardrail at a bridge approach, the relocation of the sideroad, driveway, or field entrance should receive preference over reducing guardrail length.

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5. New Guardrail Installation. New guardrail should be installed in accordance with Section 38-6 and:

   - at bridge approaches where none exists,
   - at departure ends of two-way bridges,
   - in accordance with the culvert criteria (Section 49-3.07(e)),
   - at locations where the warrants are satisfied in accordance with Figure 49-3.F and the use of the hierarchy of preferences results in a guardrail application.

6. Short-Radius Guardrail. Where practical, roadside safety should be upgraded at locations where short-radius guardrail is present or considered. See Section 38-6.09 for guidance on short-radius guardrail. Short-radius guardrail occurs when the radius is 150 ft (45 m) or less and is usually associated with a side road or entrance.

7. Departure Ends of Two-way Bridges. Due to the extreme hazard posed by the end of a bridge parapet, shielding of the departure end must be provided, even when the bridge parapet end is outside the clear zone for the opposing direction traffic. To determine the required length of need for the departure end, refer to Section 38-6.01.

8. Cable Barrier. Determine the installation of new or disposition of existing cable-guard or cable barrier from special studies. If it appears desirable to use cable barrier for roadside hazards, see Section 38-6.02. Also, contact the Bureau of Safety Programs and Engineering regarding other possible uses on a case-by-case basis.

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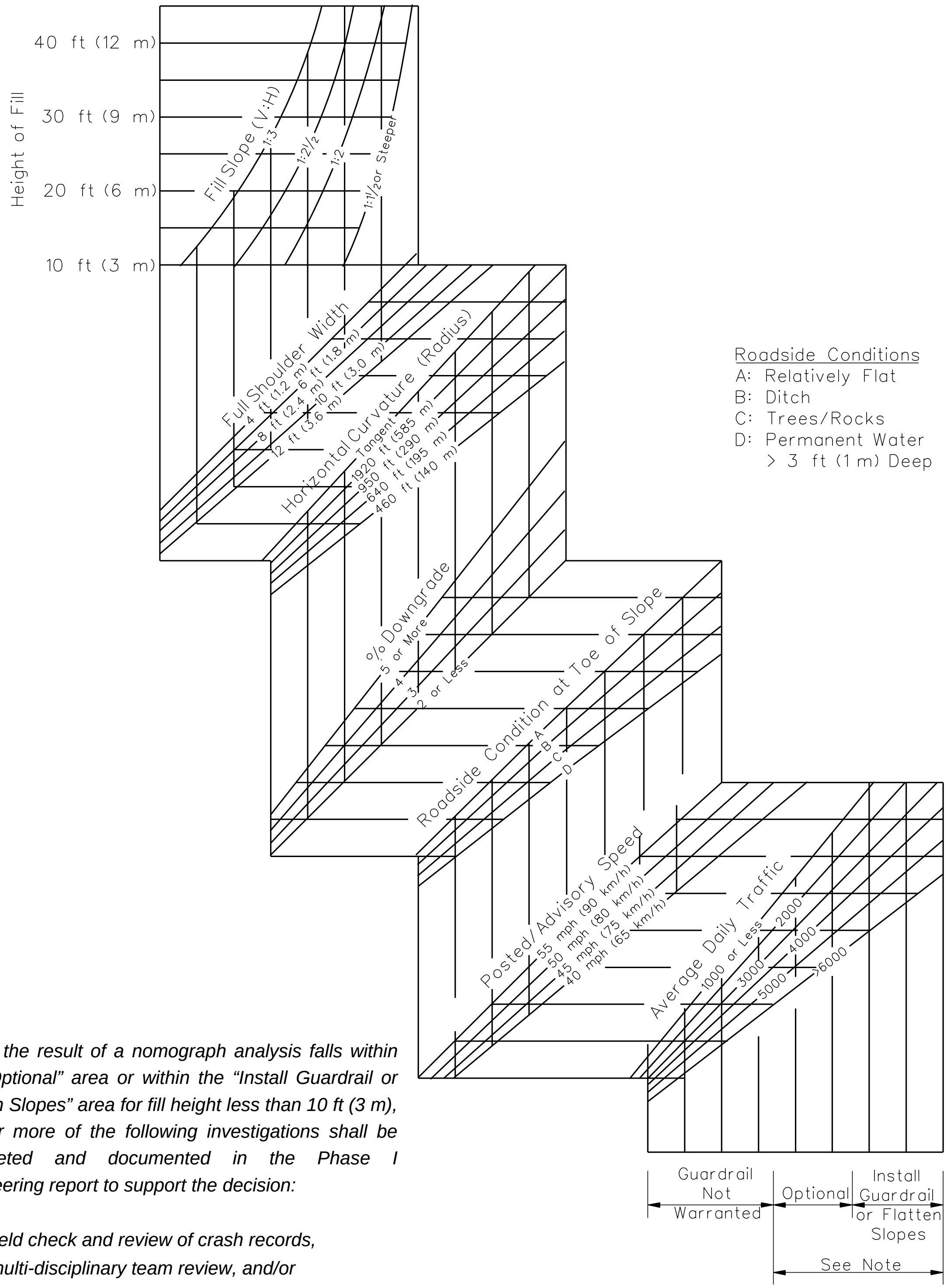

Note: When the result of a nomograph analysis falls within the "Optional" area or within the "Install Guardrail or Flatten Slopes" area for fill height less than 10 ft (3 m), one or more of the following investigations shall be completed and documented in the Phase I engineering report to support the decision:

- *field check and review of crash records,*
- *multi-disciplinary team review, and/or*
- *cost-effective economic analysis.*

GUARDRAIL WARRANTS FOR 3R PROJECTS
(Arterial Routes)

Figure 49-3.F

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49-3.07(e) Culverts

1. Cross Drainage Structures. Existing culverts with headwalls within the proposed shoulder, and existing culverts beyond the shoulder edge, but within the clear zone, should be addressed according to the following order of preferences:

   Preference 1. Remove or fill the structure and grade slopes to match the prevailing cross section. This may be possible in rare instances for abandoned cattle passes, etc. When removing culverts used as passes, a much smaller culvert may still be required for drainage, but would pose a smaller, less severe hazard.

   Preference 2. Make the culvert traversable by extending the culvert, re-grading the front slope to 1V:3H or flatter, and:

   - for culverts less than 27 in. (700 mm) in diameter, installing an end section from the *Highway Standards* which matches the front slope;
   - for culverts 27 in. (700 mm) in diameter or greater, installing an end section and a traversable grate from the *Highway Standards* which match the front slope; or
   - for multi-cell pipe culverts, elliptical pipes, or box culverts, installing an end section from the *Highway Standards* which matches the front slope and installing a traversable pipe grate if the end sections present more than a 3 ft (900 mm) opening to traffic.

   An example of how to transition the re-graded front slope at the culvert to the steeper existing front slopes before and after is shown in Figure 49-3.H.

   Preference 3. Extend the culvert to at least the proposed shoulder edge, install an appropriate end section and regrade the front slope. Then determine if guardrail is warranted based on an analysis in Chapter 38 or in lieu of analytical calculations, Figure 49-3.G may be used. An example of how to transition the re-graded front slope at the culvert to the steeper existing front slopes before and after is shown in Figure 49-3.H.

   Preference 4. Delineate the hazard according to *ILMUTCD* requirements if the above options are not appropriate.

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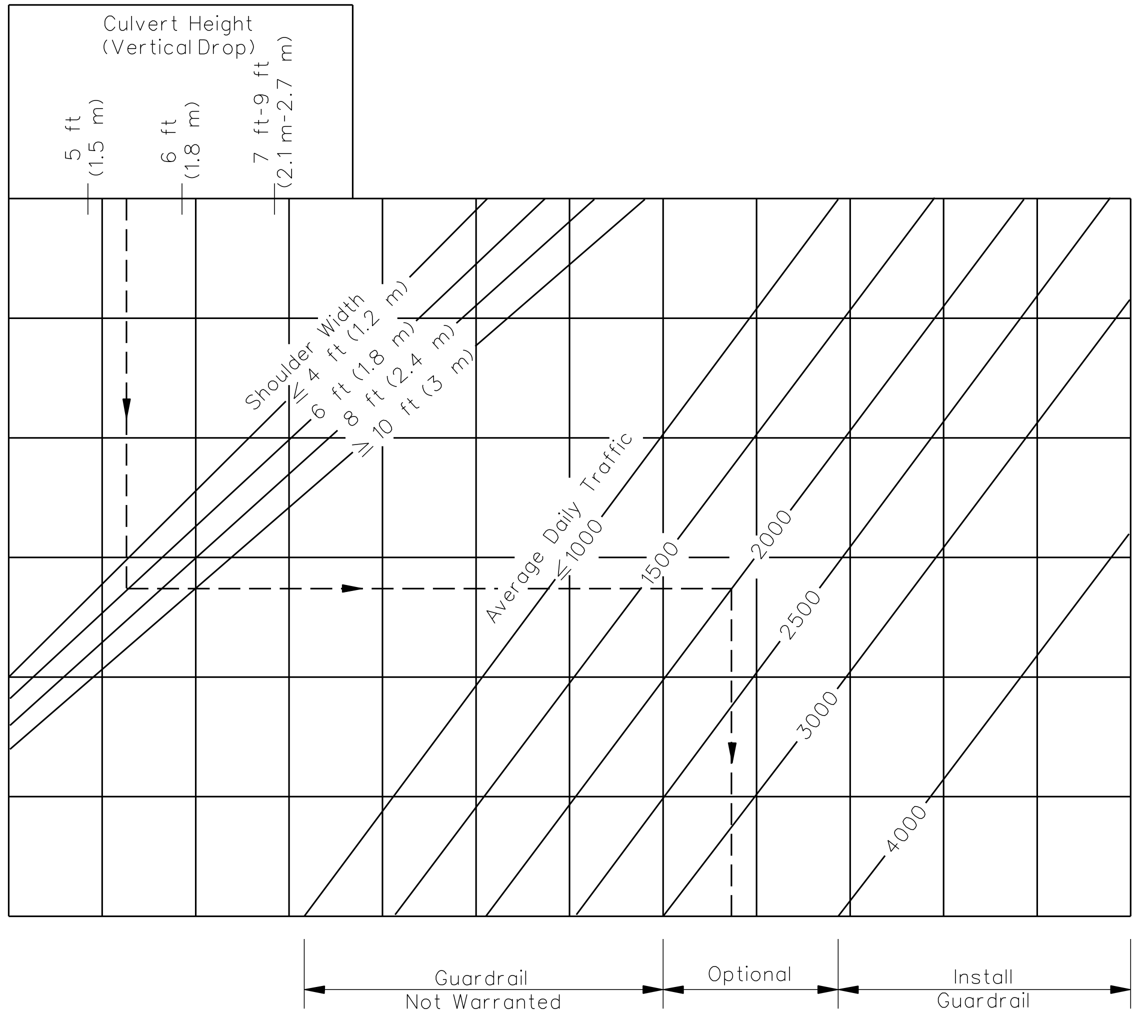

Notes:

1. *This nomograph supplements, but does not supersede Figure 49-3.F.*

2. *Culvert height includes the earth cover immediately above the culvert if it increases the "drop-off." Where the culvert height is 10 ft (3.0 m) or greater, guardrail is warranted. Follow the hierarchy of preferences in Section 49-3.07(e) for cross road culverts.*

3. *When the result of a nomograph analysis falls within the "optional" area, one or more of the following investigations shall be completed and documented in the Phase I engineering report to support the decision:*

   - *field check and review of alignment and crash records*,
   - *multi-disciplinary team review, and/or*
   - *cost-effective economic analysis.*

3R GUARDRAIL WARRANTS FOR NON-TRAVERSABLE CULVERTS

Figure 49-3.G

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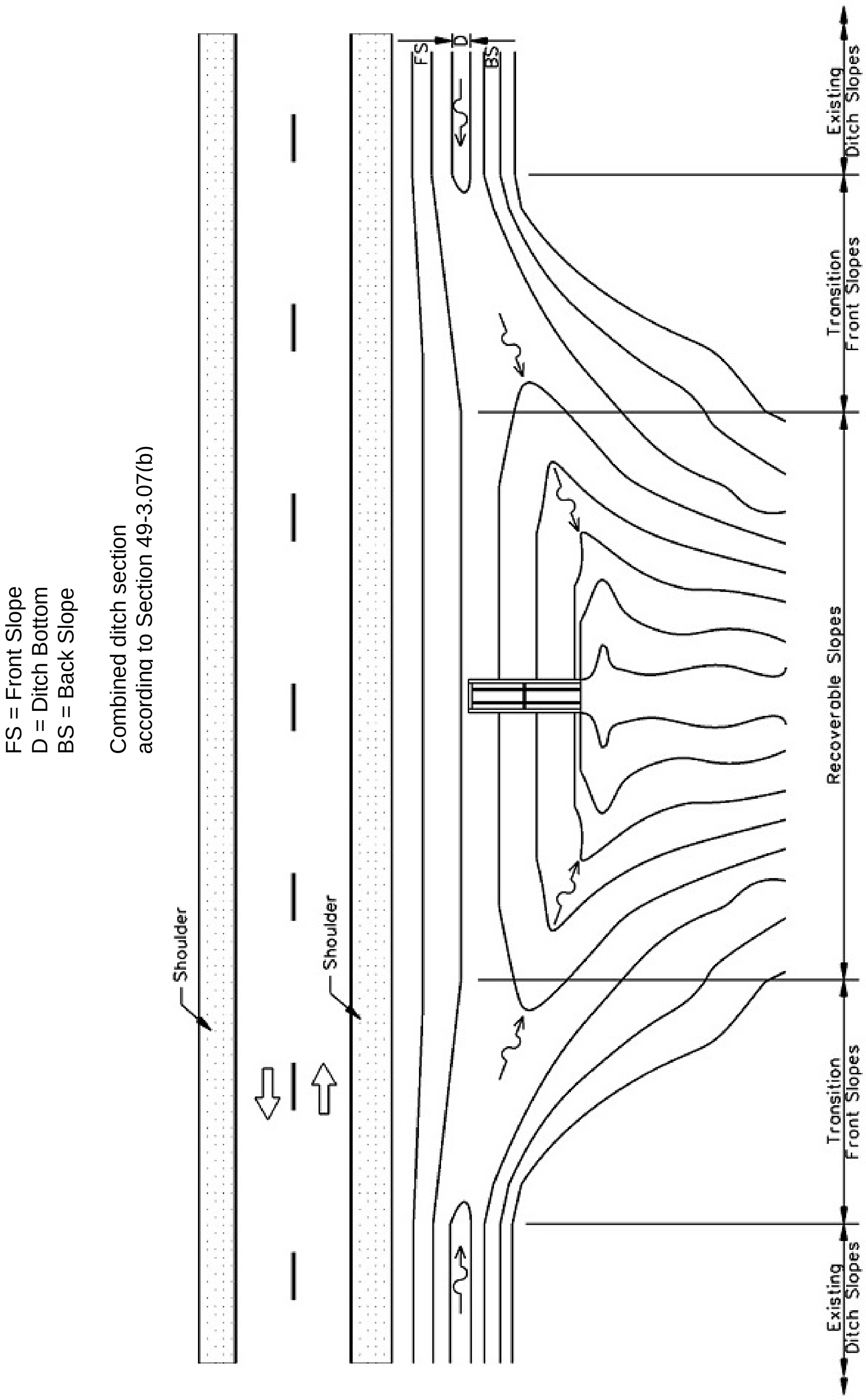

REGRADING PLAN FOR EXTENDED CULVERTS
(3R Rural Arterial Projects)
Figure 49-3.H

2. Parallel Drainage Structures. Parallel drainage structures are those that are oriented parallel to the mainline flow of traffic. They are typically used under driveways, field entrances, access ramps, intersecting side roads, and median crossovers. The ideal treatment is to remove or eliminate the entrance, and thus the parallel drainage structure, but closing or abandoning and entrance may not be practical. Where existing conditions call for a roadside barrier, provide safety treatments for parallel culverts in accordance to the following order of preferences subject to site conditions and economic analyses:

Preference 1. If the existing culvert will be replaced and right-of-way allows, realign the parallel ditch such that the drainage structure can be placed beyond the zone of being considered a hazard. Add an end section that matches the transverse slope.

Preference 2. Provide an end section [and grate for culverts larger than 24 in. (600 mm)] that matches into the transverse slope. Figure 38-4.D presents a schematic of a design for grate protection of a parallel drainage structure.

Consider the following regarding Preferences 1 and 2:

- If the proposed end section is an unacceptable hazard from only the entrance, look to decrease the hazard along the entrance by following the guidance for cross drainage structures in the preceding section. If a guardrail installation is recommended, consider its relation to both roadways.

- If the proposed end section remains an unacceptable hazard to both roadways, realignment of the ditch for the sake of safety is not recommended and a grate is not necessary. The designer should proceed to the following preferences. Use of guardrail will create a short radius guardrail installation, refer to 38-6.09.

- When evaluating the need for a traversable grate on multi-cell pipe culverts, elliptical pipes, or box culverts the same criteria should be applied.

Preference 3. Shield the drainage structure with guardrail or other approved roadside barrier.

Preference 4. Delineate the hazard according to *ILMUTCD* requirements if the above options are not appropriate.

For new or relocated entrances or driveways, follow the policy in Sections 38-4.05 and 38-4.06(c).

Where existing culverts will remain, be replaced, or be extended, and a roadside barrier will not be necessary, regrade the transverse slopes out to the highway right-of-way. These slopes may not be steeper than 1V:4H.

Parallel drainage structures may be closely spaced because of frequent driveways and intersecting roads. In such locations, it may be desirable to convert the open ditch into a

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closed drainage system and backfill the areas between adjacent driveways. This treatment will eliminate some length of ditch section and the transverse embankments with pipe inlets and outlets. However, care must be used to avoid creation of open frontage that would allow uncontrolled access.

The designer should reference Section 3-500, "Construction/Reconstruction and Maintenance of Sideroad and Street Intersections with State Highways," of the Bureau of Operations' *Maintenance Policy Manual* for guidance.

49-3.07(f) Sign and Light Supports

Posts or poles used to support signs or lights to remain within the clear zone should be breakaway. Wood sign supports may be modified to properly reduce the cross sectional area or replaced with breakaway supports.

49-3.07(g) Trees

Trees maturing to a diameter greater than 4 in. (100 mm), unless shielded by a protective device required for other purposes, shall be removed within the clear zone. Trees on back slopes that are not likely to be impacted by vehicles may generally remain in place. In cases where unusual specimens are in jeopardy, guardrail or attenuator protection may be considered as an alternative to removal; see Chapter 59.

49-3.07(h) Concrete Signal Bases

Concrete signal bases (Type B) within the clear zone and extending higher than 4 in. (100 mm) above the ground line shall be removed, and standard supports with frangible bases installed where appropriate. Note: Mast arm signal supports cannot have frangible bases.

49-3.07(i) Curbs

Curbs higher than 4 in. (100 mm) within the shoulder area should be removed where posted speeds are greater than 45 mph. The proper placement of traffic control devices shall be reviewed before considering the removal of corner island curbs where such devices are located. Curb removal is not intended to include intermittent center channelizing islands separating two-lane, two-way traffic and supplemented by illumination. Reflectorizing devices should be placed on curbs in accordance with the Bureau of Operations practices to improve delineation.

49-3.07(j) Traffic Control Devices

All traffic control devices shall conform to the *Illinois Manual on Uniform Traffic Control Devices*.

49-3.07(k) Mailbox Turnouts

The design and construction of mailbox turnouts should be in accordance with the criteria in Chapter 58 and the *Highway Standards*. Where appropriate, the designer should discuss the mailbox supports considered hazardous and within the clear zones with the property owners:

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- to inform the owner of the potential severity of the support, such as the results of pertinent research and tests as reported in the TRB Paper "The Rural Mailbox – A Little Known Hazard";

- to inform the owner of the possibility of personal liability; and

- to request the owner to change the support to reduce the potential seriousness of the hazard. Changed supports will be consistent with the designs contained in *AASHTO Roadside Design Guide.*

49-3.07(l) Lighting and Landscaping

Installation of lighting to improve operations and/or safety should be considered in accordance with the guides in Chapter 56. Generally, landscaping should be directed toward replacing appropriate existing plants and turf removed or damaged by construction and, where practical, planting for safety or erosion control purposes. See Chapter 59.

49-3.07(m) Above-Ground Utilities

Where practical, above ground utility facilities should not be allowed to remain inside the clear zone, except where protected by devices required for other purposes. Existing utility facilities may generally remain:

- where located beyond non-traversable ditch cross sections, or

- where right-of-way is so narrow that the maximum adjustment possible within the existing right-of-way is minimal and considered impractical.

Where regrading of the back slopes is necessary for a significant length within the area of utility facilities, the utilities should be relocated according to the Bureau of Operations' publication *Accommodation of Utilities on Right-of-Way of the Illinois State Highway System*. See Section 6-1.02 for other publications.

49-3.07(n) Airports

Near airports, the erection of any signs, trusses, light supports, structures, etc., 15 ft (4.5 m) or higher than the roadway, shall be coordinated with Aeronautics. Such obstructions and under what conditions they may apply to clear zone heights are described in Chapter 11.

49-3.07(o) Other

There may be other non-Department-owned objects within the desired clear zone that may be roadside obstacles. Accordingly, they should also be evaluated.

49-3.08 <u>Railroad Crossings and Signals</u>

Railroad crossings and signals should be upgraded prior to or concurrent with 3R projects. When work on existing railroad crossings, new crossings, protection devices, structures, etc., requires coordination of planning with railroad companies and/or the Illinois Commerce

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Commission, the results of these activities should be included in the Phase I engineering report. Also, coordinate, as necessary, with the IDOT Bureau of Rail in the Office of Intermodal Project Implementation to ascertain the status of affecting railroad improvements or abandonments; see Chapter 7.

Where the existing railroad crossing surface is in good condition and will remain, the roadway overlay shall be tapered to match the existing crossing profile. If required by current practices, the crossing surface outside the traveled way should consist of bituminous or other approved material.

Locate the crossing warning signal devices in accordance with current safety requirements and upgrade if not in conformance with State guidelines as discussed in Chapter 7 and in the IDOT publication *Requirements for Railroad/Highway Grade Crossing Protection*. Any other associated work performed must also meet State guidelines.

If, as an exceptional case, there will be a significant lapse of time in the relocation of railroad warning signal devices, the widened pavement should be constructed up to the crossing. Offsets to the existing warning signal devices should temporarily consist of tapered edge lines and diagonal pavement markings. If the location of the existing warning signal devices precludes this treatment, taper the widened pavement to the existing pavement width at or near the signal location.

Plans showing required changes in railroad facilities should be prepared in time to enable agreement negotiations to be concluded so that railroad work may proceed concurrently with that of the highway contract. The appropriate offices, on a project-by-project basis, shall approve variances to this procedure. See Chapter 7.

49-3.09 Bridges

49-3.09(a) Bridge Condition Reports/Structure Sketches

A Bridge Condition Report (BCR) and a Proposed Structure Sketch are required for every structure within a roadway section covered by a Phase I engineering report or when a bridge itself is the reason for preparing a Phase I engineering report. In advance of submitting the BCR and Proposed Structure Sketch to the Bureau of Bridges and Structures (BB&S) for review and concurrence, a typical section that shows the proposed clear roadway bridge width is approved by BDE. Before design approval can be granted, all BCRs shall be approved by the BB&S and concurrence also must be received on all Proposed Structure Sketches.

A Bridge Condition Report also is required for a bridge proposed to remain in place. This will ensure that the bridge meets the minimum requirements for width, safety, and structural capacity. However, the Illinois Structure Information System-Master Report (R107) may be substituted for a Bridge Condition Report.

See Section 39-3.02 for more information on Bridge Condition Reports.

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49-3.09(b) Scope of Work

Bridges on existing two-lane rural arterials will be rehabilitated to correct operational, structural, and/or significant safety deficiencies.

Bridges meeting the criteria in Section 49-3.09(c) will remain in place. Improvement of deficient bridge rails and curb sections and deck repair and resurfacing, when appropriate, should be performed concurrently with a 3R highway project.

Bridges not meeting the criteria for bridges to remain in place will be improved. They shall meet the criteria for improved bridges as discussed in Section 49-3.09(d). Bridges with clear roadway bridge widths less than the improved pavement widths for the appropriate volumes (see Section 49-3.03) should be improved concurrently with a 3R highway project or deferred for a period of no more than one year from the completion of the highway project.

The improvement of bridges with clear roadway bridge widths equal to or greater than the specified traveled way width, but less than those required to remain in place, and bridges with insufficient structural capacity may be deferred; however, they should be included in the Multi-Year Improvement Program (MYP). Bridges included in the MYP and classified as narrow (i.e., those having clear widths less than 2 ft (600 mm) wider than the required lane width) should be protected and delineated in accordance with Figure 49-3.I and the Bureau of Operations "Policy on Delineation of Narrow Bridges."

Improvement of deficient rails and/or curb sections, as described in Section 49-3.09(c) for an interim period, should be completed concurrently with a 3R highway project.

49-3.09(c) Criteria for Bridges to Remain in Place

Bridges on existing two-lane rural arterials will remain in place according to the following guidelines:

The clear roadway bridge width is equal to or greater than the values in Column I of Figure 49-3.J. The clear roadway bridge width will be measured between the faces of rails or curbs when curb removal is not practical.

The main supporting elements of the bridge including the bridge deck are structurally sound and capable of carrying an HS-20 (MS-18) structural design loading without exceeding 65% of the strength of any member.

Structurally sound bridge decks with poor riding quality that could jeopardize the safety of the motorist or cause undue discomfort should be repaired and resurfaced; however, resurfacing may not be extended across decks without appropriate repair and waterproofing or when the bridge cannot safely carry the additional dead load resulting from the resurfacing.

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49-3.09(d) Criteria for Improved Bridges

Minimum clear roadway bridge widths for improved bridges are provided in Figure 49-3.J. These widths will be applicable on all bridge rehabilitation projects:

- that utilize structurally sound elements of the existing bridge,
- that involve total replacement of all elements of the existing bridge, and/or
- that involve replacement bridges on short relocations.

When the Bridge Condition Report indicates deck replacement is necessary, the structure shall be widened to the extent possible without requiring substructure additions. Necessary repairs to or replacement of superstructure elements will be permitted. However, the minimum widths shown in Column I of Figure 49-3.J shall not be violated.

Bridge roadway widths resulting from the optimum use of prefabricated modular deck units may exceed those widths designated in Column II. The minimum clear roadway bridge width on marked routes will be 32 ft (9.6 m). Structural design loading for improved bridges shall be HS-20 (MS-18).

The hydraulics of proposed bridge improvements shall be analyzed to determine the capacity to accommodate floods for the frequencies shown in Column III of Figure 49-3.J. Bridges also shall be evaluated for a base 100-year flood.

Where the existing vertical alignment is maintained and there is no history of serious hydraulic deficiencies, the existing bridge waterway opening for the improved bridge may be retained. However, the designer must evaluate backwater effects of vertical realignments or minor reductions in openings.

49-3.09(e) Vertical Clearance

The minimum vertical clearance for bridges to remain in place is 14 ft (4.3 m). Economics may dictate exceptions.

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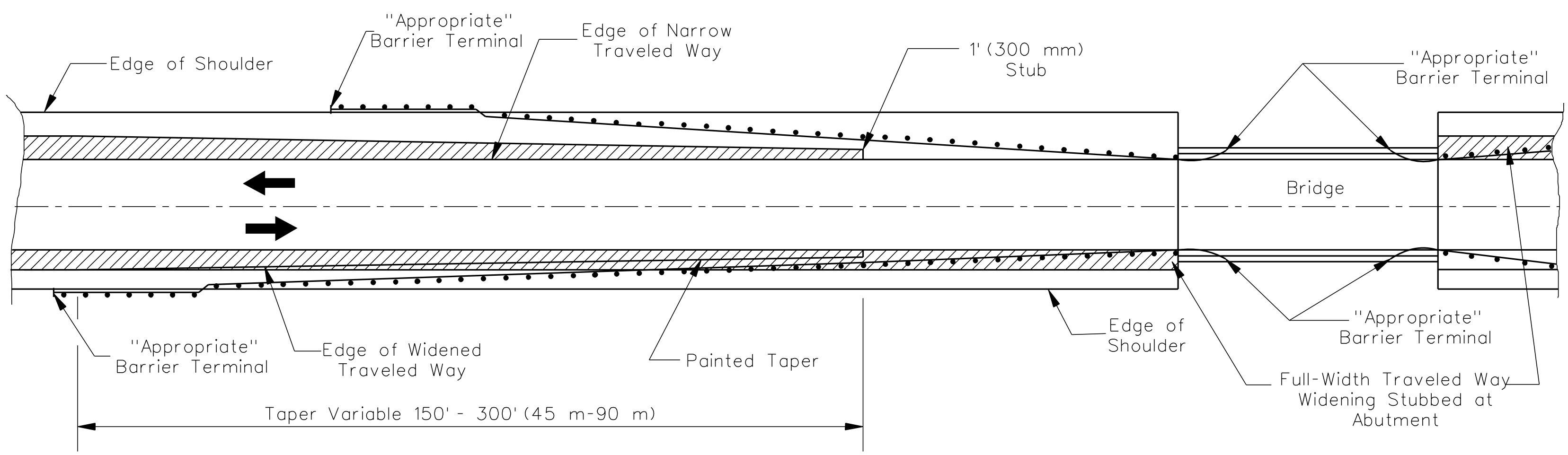

Notes:

1. *Guardrail requirement will be as determined from the length of need criteria in Section 38-6.*
2. *The "Appropriate" Barrier Terminal should be selected using the guidelines set forth in Section 38-6.*
3. *If the use of the "Appropriate" Barrier Terminal results in a roadway clear width less than that given in Section 49-3.03, a Traffic Barrier Terminal, Type 10 and 25 ft (7.6 m) of Type B guardrail may be substituted for the above terminal.*
4. *Guardrail will be installed on a 1:25 taper from the bridge end rail to the shoulder edge, then parallel to the shoulder until the length of need is fulfilled.*
5. *Signing, object markers, and delineation will be as specified by the Bureau of Operations.*
6. *See Chapter 38 and the Highway Standards for more information.*

WIDENING AT NARROW BRIDGES

Figure 49-3.I

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Current ADT	Column I Minimum Width of Bridges to Remain in Place	Column II Width of Improved Bridges (2)	Column III Design Flood Frequency
Greater than 5000	Improved Traveled Way Width (1) Plus 6 ft (1.8 m)	40 ft (12.0 m)(3)	50 yr.
5000 to 3000	Improved Traveled Way Width (1) Plus 6 ft (1.8 m)	36 ft (10.8 m)(4)	50 yr.
2999 to 1000	Improved Traveled Way Width (1) Plus 4 ft (1.2 m)	32 ft (9.6 m)	50 yr.
Less than 1000	Improved Traveled Way Width (1) Plus 2 ft (600 mm)	32 ft (9.6 m)	50 yr.

Notes:

(1) *The improved traveled way widths refer to the striped widths in Figure 49-3.A.*

(2) *These clear roadway widths will be considered the minimum widths for safety and the maximum widths for cost effectiveness. For minor arterials, an existing 32 ft (9.6 m) may remain.*

(3) *When the striped widths plus stabilized shoulders are less than 38 ft (11.5 m), a clear roadway bridge width of 36 ft (10.8 m) may be provided. A stabilized shoulder is defined as a paved shoulder and/or an aggregate shoulder at least 6 in. (150 mm) thick.*

(4) *Clear roadway bridge widths less than 36 ft (10.8 m) may be approved, on an exception basis, when all of the following conditions exist*:

- *The width of the existing or improved striped width plus stabilized shoulders, located between logical termini, will not be equal to or greater than 36 ft (10.8 m)*.
- *Projected traffic growth is minimal*.
- *The proposed clear roadway bridge width will be consistent with the width of other bridges to remain in place along the roadway section. In addition, no upgrading of the roadway is contemplated within the foreseeable future.*
- *Existing and projected truck traffic is moderate (10% or less of ADT).*

(5) *If an exception to a bridge width is warranted, the Phase I engineering report shall document the basis (minutes from a coordination meeting) for proposing and selecting the lesser width. However, for bridges located on the arterial system, the minimum clear roadway bridge width for improved bridges shall be no less than 32 ft (9.6 m).*

3R RURAL PRINCIPAL ARTERIAL BRIDGE CROSS SECTION ELEMENTS(5)

Figure 49-3.J

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49-4 URBAN ARTERIAL HIGHWAYS AND STREETS

49-4.01 Application

Section 49-4 is applicable to resurfacing, rehabilitation, and restoration (3R) projects on the State highway system that are:

- urban arterials,
- marked urban highways or streets functionally classified as collectors, or
- expressways (project-by-project basis).

49-4.02 Scope of Work

A 3R project on an urban arterial highway or street may include work such as lane widening, the addition of auxiliary lanes, channelization, median installation, revision of median type, median widening, resurfacing in conjunction with appropriate widening, new or replaced curb and/or gutter, curb ramps to meet the accessibility criteria, pavement markings, landscaping, lighting, and any associated utility adjustments. Except for relatively short sections, 3R work does not include the addition of continuous through lanes that change the basic number of lanes throughout the project.

Other than widening the traveled way, much of this work may also be included in resurfacing only projects. Widening and resurfacing or resurfacing only, in general, should also include any associated improvements necessary to ensure adequate structural support for the new pavement. Widening and resurfacing and resurfacing of parking lanes, replacement of curbs and gutters, sidewalk construction/ replacement, curb ramps to meet accessibility criteria, and other work performed on municipally maintained facilities will be subject to State policy on joint participation improvements as discussed in Chapter 5.

Where considerable amounts of right-of-way will be acquired along a significant length of the project to accommodate widening and resurfacing, most geometric design criteria should be in accordance with the reconstruction requirements of the applicable chapters in this *Manual* (e.g., Chapter 48). Some highway elements may be designed to criteria consistent with restricted site conditions and 3R objectives.

49-4.03 Design Speed

Design speeds for 3R projects on urban and suburban arterials may be the regulatory speed limit when appropriate. A regulatory speed of 45 mph is the maximum design speed where (1) a two-way left-turn (TWLT) lane is allowed in the street/highway design, and (2) continuous curbing is used along either edge of the traveled way.

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49-4.04 Roadway Cross Section Elements

For uncurbed urban and suburban arterial facilities, the criteria in Section 49-3.03 for rural facilities will apply. Typical practice is to resurface existing curbed pavements with through lanes of 10 ft (3.0 m) or wider (e-e) or turning lanes (e-f), TWLT lanes (e-e), and 8 ft (2.4 m) (e-f) or wider parking lanes without widening except on Designated Truck Routes (DTR). On DTR routes, prepare special studies to support retaining through lanes less than 11 ft (3.3 m) (e-e) wide.

Where widening will be accommodated within the existing right-of-way or where right-of-way acquisition is minimal, the cross section elements may be consistent with site conditions. Under these conditions, through and TWLT lanes may be striped as 11 ft (3.3 m) and other auxiliary lanes may be 10 ft (3.0 m) wide. Parking lanes may be 8 ft (2.4 m) wide.

49-4.05 Capacity

Design capacities, at a minimum, should be adequate for current traffic at a level of service D.

49-4.06 Diagonal Parking

Parking (existing or proposed) should generally be parallel and adjacent to the curb. Diagonal parking may be permitted to remain if a brief engineering analysis of the existing angle parking is included in the Phase I engineering report and the analysis clearly demonstrates that there will be no adverse effect on street capacity and safety. The analysis must describe parking characteristics, crash history, and an observation of street operations and potential problems. See Chapter 48 for more information.

49-4.07 Horizontal Alignment

49-4.07(a) V = 50 mph (80 km/h)

Where the design speed equals 50 mph (80 km/h), the horizontal alignment criteria in Section 49-3.04 for rural arterials will apply to urban arterial 3R projects.

49-4.07(b) V ≤ 45 mph (70 km/h)

For low-speed (V ≤ 45 mph (70 km/h)) urban streets, the designer will use Figure 49-4.A to determine the acceptability of existing horizontal curves. Where a horizontal curve will be improved (i.e., flatten the radius and/or increase the superelevation), the designer will also use Figure 49-4.A for the reconstructed horizontal curve.

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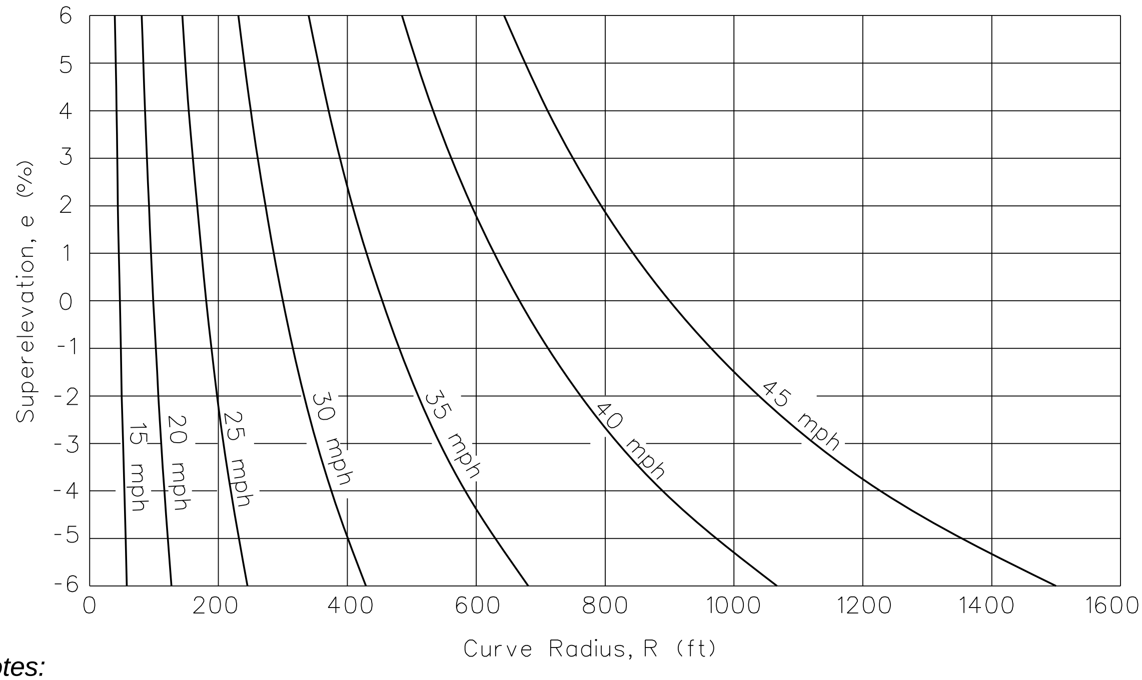

Notes:

1. *The figure provides a range of operating speeds and superelevation rates that are used to determine an acceptable curve radii.*

2. *AASHTO Method 2 is used to distribute superelevation and side friction for low-speed urban streets. Therefore, the basic point-mass equation applies:*

$$R = \frac{V^2}{15\,(e/100 + f_{max})}$$

Where: R = *curve radius, ft*
V = *speed, mph*
e = *actual superelevation rate, percent*
f_{max} = *assumed maximum side-friction factor (see Figure 48 5.B) for selected speed, decimal*

3. *For curves that fall between the -2% and +2% lines, remove the adverse crown slope through the curve. This will ensure that the maximum comfortable side-friction factor is not exceeded due to a negative slope in one direction of travel. It will also minimize potential rollover of trucks (on dry pavement) with low rollover thresholds and minimize possible skidding of trucks with smooth tires on polished, wet pavement surfaces.*

4. *The maximum superelevation rate for new construction is 4%. For reconstruction and 3R, a maximum rate of 6% may be considered to remain in place.*

HORIZONTAL CURVES TO REMAIN IN PLACE
(Low-Speed Urban Streets)
(US Customary)

Figure 49-4.A

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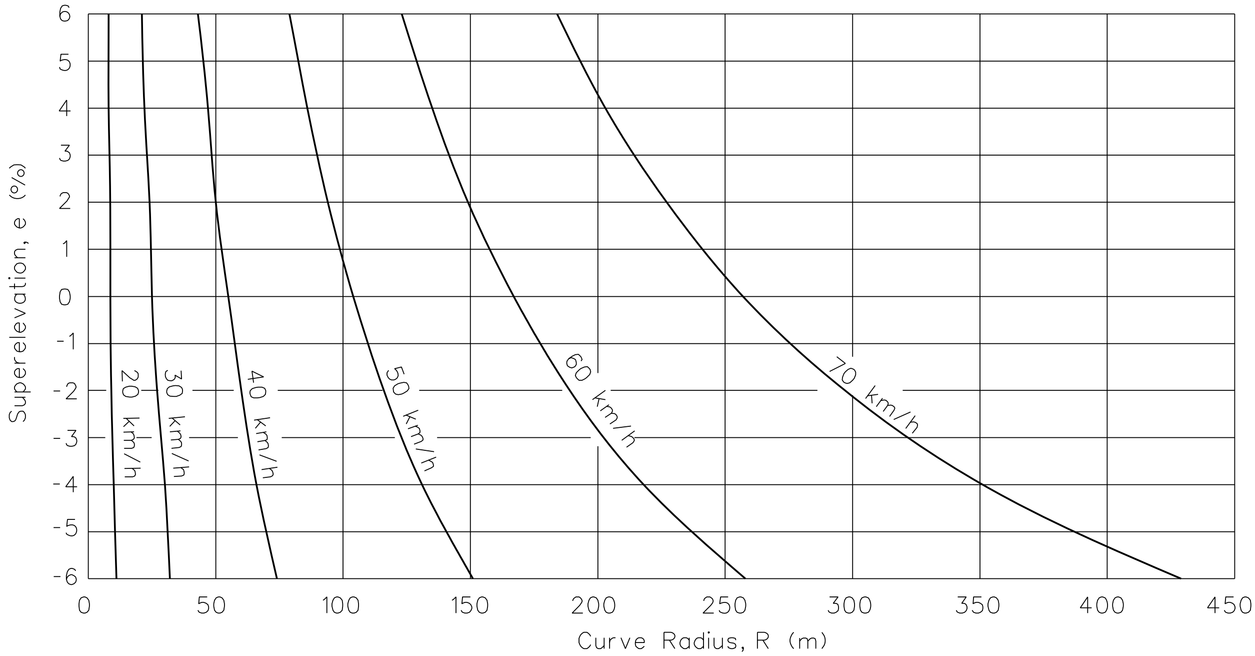

Notes:

1. *The figure provides a range of curves in feet (meters) operating speeds and superelevation rates that are used to determine a comfortable operating speed acceptable curve radii.*

2. *AASHTO Method 2 is used to distribute superelevation and side friction for low-speed urban streets. Therefore, the basic point-mass equation applies:*

$$R = \frac{V^2}{127\,(e/100 + f_{max})}$$

Where: R = *curve radius, ft*
V = *speed, mph*
e = *actual superelevation rate, percent*
f_{max} = *assumed maximum side-friction factor (see Figure 48 5.B) for selected speed, decimal*

3. *For curves that fall between the -2% and +2% lines, remove the adverse crown slope through the curve. This will ensure that the maximum comfortable side-friction factor is not exceeded due to a negative slope in one direction of travel. It will also minimize potential rollover of trucks (on dry pavement) with low rollover thresholds and minimize possible skidding of trucks with smooth tires on polished, wet pavement surfaces.*

4. *The maximum superelevation rate for new construction is 4%. For reconstruction and 3R, a maximum rate of 6% may be considered to remain in place.*

HORIZONTAL CURVES TO REMAIN IN PLACE
(Low-Speed Urban Streets)
(Metric)

Figure 49-4.A

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The basic objective for improving conditions on the existing horizontal alignment of low-speed urban streets (V ≤ 45 mph (70 km/h)) is to retain the existing alignment and to check for comfortable operating speeds by using Figure 49-4.A. This figure assumes the use of AASHTO Method 2 for the distribution of side-friction and superelevation to determine the appropriate superelevation rates in conjunction with existing radii and posted speeds. See Section 48-5 for more information.

49-4.08 Vertical Alignment

The vertical alignment criteria in Section 49-3.05 for rural arterials will apply to urban arterial 3R projects.

49-4.09 Intersections

The intersection criteria in Section 49-3.06 for rural arterials generally will apply to urban arterial 3R projects. In addition, the following will apply.

49-4.09(a) Turning Radii

In urbanized areas, right-turn maneuvers at intersections are critical for two reasons. One is the speed at which the design vehicle can make a right turn from the main road onto a side street; the second is how much encroachment, assuming the selected design vehicle, will occur into opposing lanes when the design vehicle makes a right turn onto the main road. For right turns at urban intersections, the following guidelines should be considered for 3R projects:

1. Simple radii of 15 ft to 25 ft (4.5 m to 7.5 m) are adequate for a passenger car design vehicle. These radii may be retained on existing side streets where:
   - very few trucks are expected to turn into the side street,
   - encroachment by a single unit or tractor/semitrailer unit into opposing lanes of the main road is acceptable, or
   - a parking lane is present and parking is restricted a sufficient distance from the intersection thereby providing a larger area for a right-turn maneuver.
2. Where practical, use a simple radius of 30 ft (9 m) or a two-centered curve at all major intersections and at all minor intersections with some frequency of truck turning volumes. This design will provide for the single-unit vehicle and the occasional tractor/semitrailer unit.
3. At intersections where tractor/semitrailer combinations and buses turn frequently, provide a simple radius of 40 ft (12 m) or more or a two-centered curve.

49-4.09(b) Curb Cuts/Ramps

Curb cuts/ramps shall meet the accessibility criteria in Chapter 58.

49-4.09(c) Intersection Sight Distance (ISD)

At urban, public road intersections with a two-way stop condition or at signalized intersections where right-turn-on-red is allowed, provide ISD along the arterial for the regulatory or posted speed. Use a distance of 14.4 ft (4.4 m) from the edge of the traveled way to the eye of the stopped motorist. See Chapter 36 for details on ISD.

49-4.10 <u>Roadside Treatment and Highway Appurtenances</u>

Clear zones along urban arterials are as follows:

1. Where the arterial is curbed, no obstacles should be located closer than 1.5 ft (500 mm) from the face of curb. This distance is not considered a clear zone, but an operational offset. Make every effort to provide the clear zones of a rural cross section. Where parallel parking lanes are included, a 1 ft (300 mm) clearance to the face of curb may be considered.

2. Where the arterial has a rural cross section, minimum clear zone widths should be:

   - 18 ft (5.5 m) or the non-traversable ditch if less, where the regulatory speed is equal to 50 mph (80 km/h);
   - 10 ft (3 m) where the regulatory speed is 45 mph (75 km/h); or
   - the shoulder width where the regulatory speed is 40 mph (65 km/h) or less.

3. For the treatment of roadsides and highway appurtenances other than described above, as appropriate for the cross section, refer to Section 49-3.07.

   - Where pedestrian traffic is significant, breakaway sign and light supports should not be used.
   - Where the removal of trees may adversely affect the roadside environment, these trees should be removed only when necessary for reasons of safety.

49-4.11 <u>Railroad Crossings and Signals</u>

The criteria in Section 49-3.08 for rural arterials will apply to urban arterial 3R projects.

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49-4.12 Bridges

49-4.12(a) Bridge Condition Reports/Structure Sketches

The information in Section 49-3.09(a) for rural arterials will apply to urban arterial 3R projects.

49-4.12(b) Criteria for Bridges to Remain in Place

Urban bridges may remain in place:

- where they meet the structural requirements for rural bridges (see Section 49-3.09(c)) including those requirements for decks and bridge rails;
- where the clear roadway bridge width is sufficient to accommodate the number of approach lanes; and
- where the clear roadway bridge width includes traffic lanes 10 ft (3 m) or wider.

For urban bridges, bridge deck repairs similar to those cited for rural bridges may be undertaken. However, bituminous resurfacing carried across bridge decks is restricted as with rural bridges.

49-4.12(c) Criteria for Improved Bridges

Urban bridges that do not meet the criteria to remain in place should be improved. Such improvements shall include the following:

- The bridge shall meet the structural requirements of improved rural bridges (refer to Section 49-3.09(d)).
- The bridge shall accommodate the number of lanes and the median on the approach roadways.
- The bridge shall provide lane widths equal to those on the roadway approaches but not less than 11 ft (3.3 m).

Parking lanes on the approach roadways usually are not carried across urban bridges.

49-4.12(d) Vertical Clearance

The minimum vertical clearance for bridges to remain in place is 14 ft (4.3 m). Economics may dictate exceptions.

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49-5 HIGH-SPEED, MULTILANE HIGHWAYS (WITHOUT ACCESS CONTROL)

49-5.01 General

High-speed, multilane highways are those facilities where the regulatory speed is 50 mph (80 km/h) or higher. In general, for 3R projects, the design will be determined on a project-by-project basis. Section 49-5 provides some guidance on the design of these projects.

49-5.02 Shoulders

If bituminous shoulders do not exist, the designer should include a minimum 1 ft (300 mm) bituminous strip adjacent to each edge of the traveled way. For ADT's over 10,000, the designer should consider the use of 3 ft (900 mm) bituminous right shoulders for each roadway.

49-5.03 Medians/Posted Speed

During the preparation of the Phase I engineering report for 3R work on high-speed, multilane highways, the designer should evaluate the design of the existing median relative to the existing and proposed posted speeds. Although it is necessary to provide an unencumbered median of appropriate width on new and reconstructed high-speed, multilane highways, this is not unconditionally required for 3R projects. On these projects, the need for a median, a median barrier, and/or appropriate median width is primarily based on cost and safety-effectiveness.

To determine whether adjustments should be made to the median design and/or posted speed, the following factors should be examined:

1. ADT. Lower ADT's provide lower exposure to and probability of crashes and operational problems. ADT's less than 10,000 are considered low because this is near the threshold of a four-lane warrant.

2. Safety Analysis. Conduct a project safety analysis as described in Section 11-2.02(f) for each 3R project.

3. Speed. Because these high-speed facilities are posted either at 50 mph or 55 mph, it generally is not effective to simply reduce the posted speed by 5 mph or 10 mph, respectively. However, if other factors strongly suggest a posted speed of 45 mph or less, the facility would then be rehabilitated using 3R criteria for rural arterials (Section 49-3) or 3R criteria for urban arterials (Section 49-4).

4. Intersections. Frequent and closely spaced intersections suggest a potential for crashes involving left-turning vehicles. This may be especially true where no median exists or where a narrow median exists that does not allow the development of separate left-turning lanes. At intersections that exhibit a significant number of crashes due to the absence of left-turn lanes, consider designing channelization at those intersections. Also, investigate the need to add right-turn lanes.

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5. Other Factors. Multilane highways should be closely examined for design and operational continuity. Evaluate the influences of speed and cross section due to adjacent sections, length of project, alignment, and current and future potential for abutting land development.

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49-6 UNMARKED ROUTES ON THE STATE HIGHWAY SYSTEM

49-6.01 General

The following general information applies to unmarked rural collector and local highways on the State highway system:

1. Application. Section 49-6 is applicable to resurfacing, rehabilitation, and restoration (3R) projects that meet all of the following:

   - the facility is eligible for Federal funding,
   - the facility is an unmarked route, and
   - the facility is on the State highway system.

   In addition, proposed improvements to unmarked routes are usually initiated only after an agreement is reached with a local agency for a jurisdictional transfer of the route. See Section 43-4.

   If the purpose and scope of the project is intended to replace or expand the facility, then Section 49-6 is not appropriate, and reconstruction criteria will apply.

2. Exceptions. Where these criteria will result in improvements that are inconsistent with adjacent sections or are not cost and safety-effective, the actual treatment implemented will be on the basis of a special study and evaluation.

3. Local System. Where the route is also on the local system and it is unclear which policies should be used, the district should coordinate the proposed improvements with the Central Office and, subsequently, with either the county or municipality.

4. Jurisdictional Transfers. On unmarked routes, the districts should negotiate jurisdictional transfers preferably before improvement projects are included in the program. However, when improvements are proposed, any additional work that exceeds the 3R criteria, primarily undertaken to minimize future maintenance costs and ease the jurisdictional transfer, should be carefully evaluated for long-range cost effectiveness.

5. Ditches. Drainage improvements or restoration by ditch cleaning should be performed as necessary to extend the service life of the pavement and to minimize inundation of the pavement and adjacent properties. Suitable portions of the excavated material may be used for embankment and shoulders.

6. Safety Analysis. Conduct a project safety analysis as described in Section 11-2.02(f) for each 3R project. This analysis will guide selection of cost-effective countermeasures for medians and other project locations.

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49-6.02 Design Speed

The typical design speed for rural projects on unmarked routes on the State highway system is 55 mph (90 km/h) or the regulatory speed whichever is less. Design speeds for urban and suburban areas may be the regulatory or posted speed limit. A posted speed of 45 mph is the maximum speed where: 1) a TWLT lane is used in the street/highway design, and 2) continuous curbing is used to delineate the edges of the traveled way.

49-6.03 Roadway Cross Section Elements

Figure 49-6.A presents criteria for roadway cross sections for 3R projects on rural unmarked routes on the State highway system.

49-6.04 Horizontal Alignment

49-6.04(a) Radius of Curvature/Superelevation

An existing horizontal curve may remain in place if its comfortable operating speed is not more than 15 mph (25 km/h) less than the regulatory speed for the highway but not less than 30 mph (50 km/h). Appropriate advisory speed signs will be used on horizontal curves where the comfortable operating speed is more than 5 mph (10 km/h) less than the regulatory speed.

Superelevation rates for horizontal curves on rural facilities to remain in place shall be commensurate with the comfortable operating speed of the curve using a maximum rate of 8%. See Figure 49-3.B for guidance on curves to remain in place.

49-6.04(b) Traveled Way/Shoulder "Rollover"

Through horizontal curves, the maximum rollover (algebraic difference between slopes) at the traveled way/shoulder intersection should not be greater than 10% where the proposed (or remaining) shoulder width is 6 ft (1.8 m) or wider. Where the shoulder width is 4 ft (1.2 m) or less, the maximum rollover may be 12%. Where 1 ft (300 mm) paved shoulders are used, the rollover should occur at the edge of the paved shoulder rather than at the traveled way edge for ease of construction.

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	Current ADT			
	Under 400	**400-999**	**1000-3000**	**Over 3000**
Width of Traveled Way(1)	18 ft (5.4 m)	22 ft (6.6 m)	22 ft (6.6 m)	24 ft (7.2 m)
Width of Shoulder(2)	2 ft (600 mm)	4 ft (1.2 m)	4 ft (1.2 m)	6 ft (1.8 m)
Shoulder Type	Turf (4) or Aggregate Wedge (5)		Aggregate Wedge (3)(5)	

Notes:

(1) Resurfacing only: Traveled way widths may be reduced by 2 ft (600 mm), but the traveled way width shall not be less than 18 ft (5.4 m).

(2) For rural cross sections, shoulder width includes a 1 ft (300 mm) wide paved strip for either a resurfacing or resurfacing and widening project.

(3) Use full-width, 6 in. (150 mm) thick aggregate shoulders for ADTs over 5000 in addition to the 1 ft (300 mm) wide shoulder strip. For definition purposes, a stabilized shoulder will be aggregate of 6 in (150 mm) minimum thickness.

(4) Turf will consist of compacted, stable, roadway embankment or granular material capable of supporting growth and will not contain a high percentage of organic or unstable material.

(5) The width of the aggregate wedge will be 3 ft (900 mm) or equal to the width of the usable shoulder if less than 3 ft (900 mm). The minimum wedge thickness will equal the depth of resurfacing at the edge of traveled way and tapering to zero.

ROADWAY CROSS SECTION ELEMENTS
(3R Projects on Unmarked Routes on the State Highway System)

Figure 49-6.A

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49-6.05 Vertical Alignment

49-6.05(a) Crest Vertical Curves

The following will apply:

Current ADT	Treatment
1000 or more	All existing crest curves which are not within 15 mph (25 km/h) of the posted or regulatory speed, as determined from the available stopping sight distance (SSD), will be upgraded by one of the following options: • flatten the crest curve within the existing right-of-way to satisfy 55 mph (90 km/h) (desirable) or 45 mph (70 km/h) (minimum) SSD; or • flatten the crest curve by using additional right-of-way to satisfy a 50 mph to 55 mph (80 km/h to 90 km/h) SSD. The designer should consider sight distances, intersection influences, overall safety, the need for road closures, detours, stage construction, and especially the prevailing vertical alignment in evaluating the above alternatives. Such an analysis will allow designers to determine the most practical alternative for flattening crest vertical curves.
Less than 1000	Crest curves may be retained if adequate for 20 mph (30 km/h) less than the posted or regulatory speed but not less than a 30 mph (50 km/h) available SSD.

49-6.05(b) Sag Vertical Curves

Sag curves generally may be retained.

49-6.05(c) Maximum Grades

On 3R non-freeway projects, the existing roadway grades are acceptable; i.e., flattening grades is not within the scope of a 3R project on unmarked highways.

49-6.06 Intersections

49-6.06(a) Superelevation Rate Changes Through Intersections

Superelevation rates less than that specified for the preceding horizontal alignment may be used through certain intersections because of significant intersection conflicts and when supported in the Phase I engineering report. Refer to Figure 36-1E for guidance. Agreement should be reached with the District Operations Engineer on the appropriate advisory speed to be posted for the curve and noted in the Phase I engineering report.

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49-6.06(b) Stop-Controlled Approaches on Horizontal Curves

On curved, stop-controlled approaches to the unmarked route, the existing superelevated cross section generally is left in place.

49-6.06(c) Sideroad Approach Grades

Where considerable amounts of additional right-of-way are required, geometric design criteria should be in accordance with applicable new construction/reconstruction policies where practical. Some elements may be consistent with site conditions when based on special study and analysis results.

All connecting sideroad approaches should be examined for drainage away from the unmarked route. The gradeline on the sideroad should normally drain away from the intersecting unmarked highway for 50 ft to 100 ft (15 m to 30 m) or, at a minimum, to the ditch line of the unmarked highway. If the sideroad profile is reconstructed, the minimum sideroad gradeline should be approximately -1.0% from the intersecting unmarked highway, and the maximum gradeline is -4.0%. Where the unmarked highway is on a horizontal curve, use a maximum of -2.0% on the sideroad connection to minimize rollover at the traveled way edge.

49-6.06(d) Sideroad Turning Radii

The design vehicle used for sideroad turning radii may be site specific with justification. Refer to Section 36-1 for guidance in the selection of design vehicles based on functional classification.

49-6.06(e) Intersection Sight Distance

At rural, public road intersections with a stop condition on the sideroad, provide 465 ft (140 m) of sight distance for the stopped approach in both the left and right directions along the free-flowing highway. Use a 12 ft (3.5 m) distance from the edge of the traveled way to the driver's eye.

49-6.07 Roadside Treatment and Highway Appurtenances

49-6.07(a) General

The intent of these guides is to perform cost-effective work that may reduce the number and severity of run-off-the-road crashes. Remove or shield obstacles within the clear zone, including protrusions that extend greater than 4 in. (100 mm) above the groundline, where cost effective.

49-6.07(b) Earth Slopes

Other than specifically described in Section 49-6, existing earth slopes should generally remain. Where existing right-of-way permits significant slope flattening or where grading within existing right-of-way is necessary, the designer should consider flattening earth slopes, particularly at horizontal curves.

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49-6.07(c) Clear Zones

On unmarked routes on the State highway system, clear zone widths (measured from the traveled way edge) should be in accordance with Figure 49-6.B.

<table>
<tr><th colspan="2">Roadway Criteria</th><th>Ditch Cross Sections [1]</th><th>Clear Zone</th></tr>
<tr><td rowspan="3">On Tangent</td><td rowspan="2">Regulatory Speed 50 mph (80 km/h) or greater and ADT Greater than 1000</td><td>Traversable</td><td>13 ft (4.0 m) or ROW Line [2]</td></tr>
<tr><td>Non-Traversable</td><td>13 ft (4.0 m) or
Toe of Back Slope [2]</td></tr>
<tr><td>All Others</td><td>-</td><td>10 ft (3.0 m)</td></tr>
<tr><td rowspan="3">On Curve [3]</td><td rowspan="2">Comfortable Operating Speed less than
50 mph (80 km/h)</td><td>Traversable</td><td>20 ft (6.0 m) or ROW Line [2]</td></tr>
<tr><td>Non-Traversable</td><td>20 ft (6.0 m) or Ditch Line [2]</td></tr>
<tr><td>Comfortable Operating Speed 50 mph (80 km/h) or greater</td><td colspan="2">Same as tangent Clear Zone above</td></tr>
</table>

Notes:

(1) Traversable ditch cross sections are those with at least 1V:4H front slopes, 1V:3H back slopes, and 2 ft (600 mm) wide ditch bottom. If any of these criteria are not satisfied, the ditch cross section is considered non-traversable.

(2) Use whichever is less.

(3) Clear zone values apply only to the outside of curve. Tangent clear zone values apply to inside of curve. Use Figure 49-3.B to determine comfortable operating speed.

CLEAR ZONES
(3R Projects on Unmarked Routes on the State Highway System)

Figure 49-6.B

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49-6.07(d) Guardrail

The criteria provided in Section 49-3.07(d) for the treatment of guardrail and locations warranting guardrail will also apply to unmarked routes on the State Highway System. However, any reference to Figure 49-3.F in Section 49-3.07(d) should be read as Figure 49-6.C.

49-6.07(e) Culverts

The criteria present in Section 49-3.07(e) for the treatment of culverts will also apply for unmarked routes on the State Highway System. For jurisdictional transfer projects, end treatments of cross road culverts will be in accordance with the *Bureau of Local Roads and Streets Manual* or the end treatments described in 49-3.07(e).

49-6.07(f) Mailbox Turnouts

The design and construction of mailbox turnouts should be in accordance with the *Highway Standards,* BLR-24.

49-6.07(g) Lighting and Landscaping

Installation of lighting to improve operations and/or safety should be considered in accordance with the guidelines in the *Bureau of Local Roads and Streets Manual*. Generally, landscaping should be directed toward replacing appropriate existing plants and turf removed or damaged by construction and, where practical, planting for safety or erosion control purposes. See Chapter 59.

49-6.07(h) Other

Section 49-3.07 presents criteria for rural arterials for the following roadside elements:

- sign and light supports,
- trees,
- concrete signal bases,
- curbs,
- traffic control devices,
- mailbox supports, and
- above-ground utilities.

These criteria apply to 3R projects on unmarked routes on the State Highway System.

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49-6.08 Railroad Crossings and Signals

The criterion in Section 49-3.08 for rural arterials also applies to unmarked routes on the State Highway System.

49-6.09 Bridges

49-6.09(a) Bridge Condition Reports/Structure Sketches

The information in Section 49-3.09(a) for rural arterials also applies to unmarked routes on the State Highway System.

49-6.09(b) Scope of Work

Bridges on unmarked routes on the State Highway System will be rehabilitated to correct operational, structural, and significant safety deficiencies and will be subject to the following conditions:

1. The roadway template is not anticipated to be widened beyond the proposed bridge cross section within the next 20 years.

2. Where an existing bridge is not of sufficient width to remain in place, it may be gapped within the project limits if its future rehabilitation or replacement is committed as staged construction to be completed within the next five years. No bridge will be gapped for more than one year if the clear roadway bridge width is less than the approach traveled way width.

3. Hazard panels and appropriate pavement markings will be required for all bridges which remain in place and which are narrower than the improved traveled way width; see Figure 49-3.I.

49-6.09(c) Criteria for Bridges to Remain in Place

Bridges on rural unmarked routes on the State Highway System will remain in place provided that the clear roadway bridge width is equal to or greater than the values given in Figure 49-6.D and that the structural capacity is met.

The designer should repair, retrofit, or replace any rails on bridges to remain in place that could be easily penetrated by a passenger vehicle, that show evidence of crash damage, that are in questionable condition, or that contain irregularities that could cause intolerable vehicular decelerations. If replaced, rails and their connections to the deck shall be designed to meet current AASHTO strength and safety performance standards.

Curb sections that project horizontally more than 9 in. (225 mm) but less than 3 ft (900 mm) from the face of rail will be removed or new rail elements installed in accordance with the standards for bridge rail retrofit.

Structurally sound bridge decks with poor riding quality that could jeopardize the safety of the motorist or cause undue discomfort should be repaired and resurfaced; however, resurfacing

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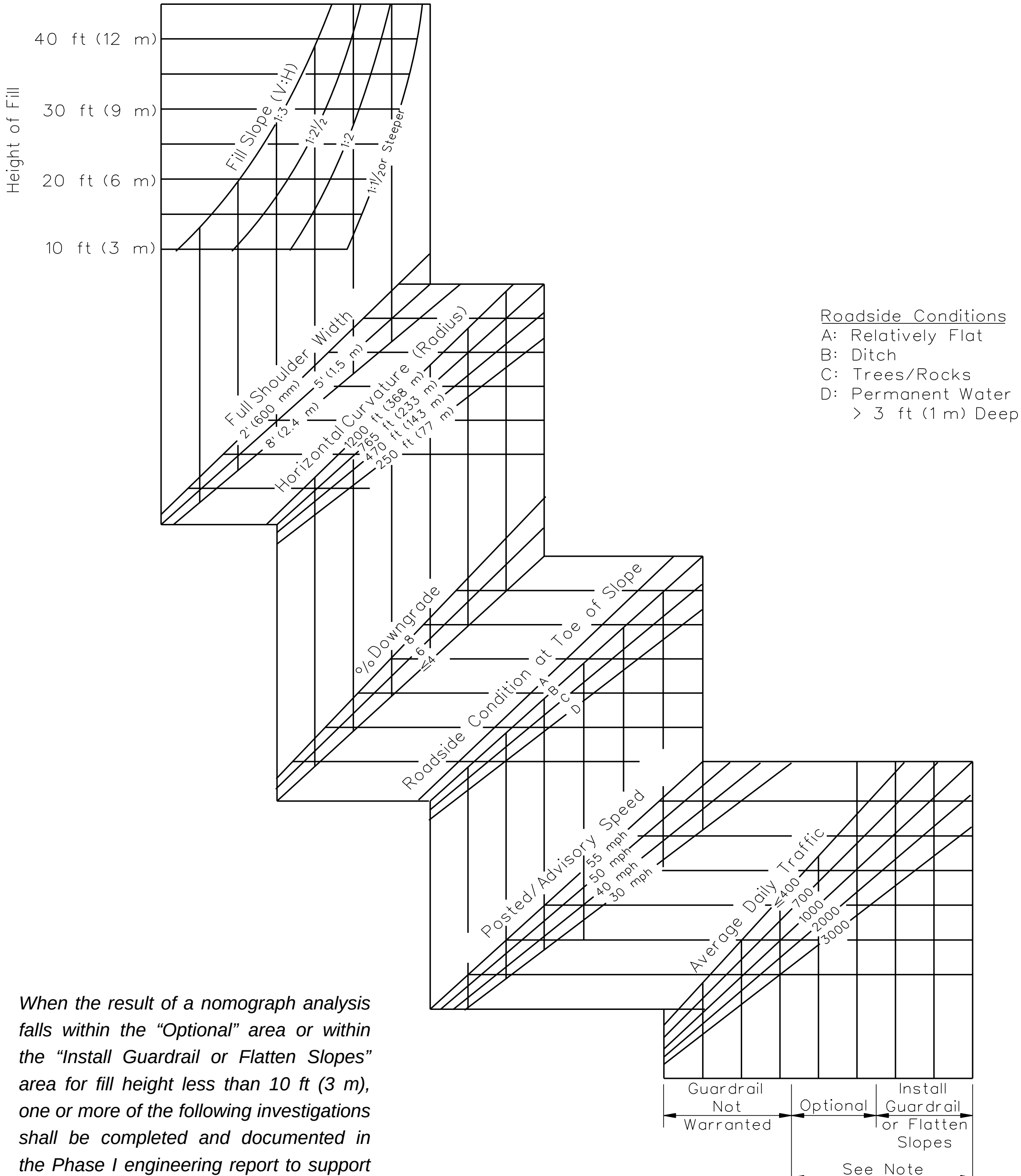

Note: When the result of a nomograph analysis falls within the "Optional" area or within the "Install Guardrail or Flatten Slopes" area for fill height less than 10 ft (3 m), one or more of the following investigations shall be completed and documented in the Phase I engineering report to support the decision:

- *field check and review of crash records,*
- *multi-disciplinary team review, and/or*
- *cost-effective economic analysis.*

GUARDRAIL WARRANTS FOR 3R PROJECTS
(On Unmarked Routes on the State Highway System)

Figure 49-6.C

may not be extended across decks without appropriate repair and waterproofing or when the bridge cannot safely carry the additional dead load resulting from the resurfacing.

49-6.09(d) Criteria for Improved Bridges

All rehabilitated or replaced bridges will be constructed to a clear roadway width equal to the values in Figure 49-6.E. The widths assume a rural type cross section approaching the bridge.

49-6.09(e) Vertical Clearance

The minimum vertical clearance for bridges to remain in place over an unmarked route is 14 ft (4.3 m). Economics may dictate exceptions.

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Current ADT [(2)]	Current ADT	Current ADT	Current ADT
Under 400	**400 - 999**	**1000 - 3000**	**Over 3000**
Clear Roadway Bridge Width [(3)]			
20 ft (6.0 m)	22 ft (6.6 m)	24 ft (7.2 m)	28 ft (8.4 m)

Notes:

(1) *In all cases, except as noted in (2) below, the bridge to remain in place shall have a structural capacity of H-15 (MS-13.5) loading.*

(2) *When the current ADT is less than 75, a bridge with a structural capacity of H-10 (MS-9) loading will be acceptable if it meets the width criteria.*

(3) *Between rails or between curbs if the curb projects more than 9 in. (225 mm) beyond the face of the rail.*

(4) *In no case will the bridge be narrower than the approach traveled way.*

3R WIDTHS OF BRIDGES TO REMAIN IN PLACE [(1)(4)]
(On Unmarked Routes on the State Highway System)

Figure 49-6.D

Current ADT		
Under 3000	**3000 to 4999**	**5000 and Over**
Clear Roadway Bridge Width		
28 ft (8.4 m)	32 ft (9.6 m)	36 ft (10.8 m)

3R WIDTHS OF IMPROVED BRIDGES
(On Unmarked Routes on the State Highway System)

Figure 49-6.E

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49-7 REFERENCES

1. Special Report 214, *Designing Safer Roads: Practices for Resurfacing, Restoration and Rehabilitation*, Transportation Research Board, 1987.

2. *A Policy on Geometric Design of Highways and Streets*, AASHTO, 2011.

3. *Roadside Design Guide*, AASHTO, 2011.

4. "Are the Criteria for Setting Advisory Speeds on Curves Still Relevant?," by Mashrur Chowdbury and Davey Warren, ITE Journal, February 1998.

5. NCHRP Report 350, *Recommended Procedures for the Safety Performance Evaluation of Highway Features*, Transportation Research Board, 1993.

6. *Manual for Assessing Safety Hardware* (*MASH*), AASHTO, 2009.

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